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SOME ECOLOGICAL ASPECTS OF TROPICAL PEDOLOGY

By F. HARDY

(1) Introduction: Crop Ecology

It is maintained by some that the science of Pedology should be regarded as a branch of Pleistocene geology and that, since it has no obvious bearing on crop-growth, it should consequently be divorced from agriculture. Such an attitude is epitomized in the saying, "It is of no importance to a plant what kind of rock occurs beneath the soil in which it is rooted, so long as that plant is getting all it needs of water, air and nutrients". This clearly implies that the agriculturist can gain nothing of any value from a study of the soil itself as a natural object, whereas he may perhaps learn a great deal by a study of its physical and chemical properties. I propose in this article to examine these statements and to attempt to discover to what extent they are true.

According to Sir John Russell[1], the chief soil factors that affect the growth of plants are (1) water-supply, (2) air-supply, (3) soil temperature, (4) nutrient-supply, (5) various injurious factors, and (6) depth of soil. Coupled with these are certain atmospheric factors of which the chief are (7) air temperature, (8) air humidity, (9) air movements and (10) light. These are all factors of the environment, or ecological factors, the soil, the plant and the atmosphere being the components of a single system. Their study in relation to agriculture is called *Crop Ecology*. The methods of the crop ecologist are relatively simple, though tedious and time-absorbing. They consist of measuring the chief soil and atmospheric growth-factors within areas where the particular crop-plant that is being studied has been established. Preferably two contrasted plots are selected, one where the crop-plant is growing satisfactorily and producing well (the "good" plot) and the other where it is not so satisfactory (the "bad" plot). The plots are visited at regular periods, preferably weekly, throughout one or more growing seasons. At each visit readings are taken of various meteorological instruments set up within the plots, and soil samples are collected for laboratory examination. Notes are also made of the appearance and condition of the crop-plant. The approach is thus essentially dynamic; the object is to obtain a cinematographic picture of the environment at each site rather than just one or two snapshots.

Certain ecological factors are subject to wide fluctuations as the season progresses. Such are water-supply (the gross soil-moisture content) and its complement, air-supply (soil air-content), nutrient-supply (the "available" nitrogen, phosphate and potash) and, to a lesser extent, soil and air temperatures, humidity, air movements and light intensity. Other ecological factors are less prone to fluctuation and are relatively static, yet they may partly control, or at least bear some intimate relationship to, certain of the more variable factors. Such is soil structure, which determines not only the distribution of water and air in a soil, but also the prime factor of soil depth (meaning root-room or rooting volume). Additional static soil factors are soil texture (its content of sand, silt and clay), the total contents of nutrient elements in the soil, exchange reaction, the organic-matter content and the content of organic nitrogen.

1. Sir John Russell, *Soil Conditions and Plant Growth* (6th edition, London, 1932), p. 32.

Well-known laboratory methods have been developed for evaluating each of these dynamic and static soil constants. Tabulation and comparison of the results obtained by their use enable the ecologist to identify the particular limiting growth factor or factors responsible for the failure of the crop in the "bad" plot or its success in the "good" plot. The procedure has, for example, proved useful in Trinidad in studies of cacao and the causes of its decline in recent years.

(2) The Land Capability Survey: Applied Crop Ecology

An important application of the ecological principles outlined above has been developed by the Soil Conservation Service of the United States of America as the *Land Capability Survey,* first applied to farms in 1939. In this kind of survey, land is first classified according to ground-slope, stoniness and degree of erosion. These are expressed and mapped in symbols based on arbitrary categories of values. In addition, certain other mappable features are noted, such as the effective soil-depth (root-room), the thickness of the upper humic layer (which often coincides with rooting depth), the presence of hard-pans or gravel layers, the presence of water-tables, and so on. Soil features that cannot be mapped on the spot necessitate the collection and laboratory examination of special soil samples, for instance, surface infiltrability, subsurface permeability and porosity among the commoner physical attributes, and reaction (degree of acidity and of alkalinity), salinity, nutrient status and trace-element status, among the chemical properties.

Many of the features mentioned above comprise the same growth factors as have already been named in connection with ecological investigations. It is, therefore, evident that the Land Capability Survey is simply an ecological survey in which the more important growth-factors are assessed and put on to maps, from which the potentialities for crop production of any prescribed area, such as a farm, may be accurately determined, and appropriate agricultural systems (including crop rotations), soil conservation measures and drainage schemes, subsequently designed and applied. It is usually necessary to prepare several different kinds of maps for plotting all the information and laboratory data supplied by the Land Capability Survey, and the scale of mapping must accordingly be adequately large, for example, 25½ inches to the mile (1 acre per sq. in.), or 8 in. to the mile (10 acres per sq. in.).

The Land Capability Classification Scheme comprises eight classes of land, four of which denote land suitable for cultivation and four land unsuitable. As an example of the kind of description of Land Capability Classes which the Soil Conservation Service employs, the following may be quoted. It refers to one of the poorer classes of land suitable for cultivation, namely, "Class III:—Land subject to severe limitations which include (1) moderately steep slope, (2) high susceptibility to erosion, (3) moderate overflow hazard, (4) slow or very slow subsoil permeability, (5) excessive wetness with a hazard of waterlogging, (6) shallow depth to bedrock, hard-pan or clay-pan, (7) sandy, very sandy or gravelly soil with low moisture capacity, (8) low inherent fertility." Clearly most of the important ecological soil factors which have already been enumerated are included in this list of land features, namely, water-supply and air-supply, which are directly involved in limitations Nos. (1), (3), (4), (5) and (7); nutrient-supply, involved in limitation No. (8), and depth of soil (root-room) involved in limitation No. (6). These several limitations are either gauged during the survey by observation in the field or determined by measurement in the laboratory.

It may be profitable to enquire further into the identity and mode of operation of the fundamental factors responsible for the differentiation and magnitude of these ecological limitations. Obviously, the first two limitations, No. (1) slope and No. (2) erosion, depend on topography and so also to some extent does limitation No. (6), shallowness of soil. By contrast, No. (8) depends on quite a different cause, namely, the chemical composition of the parent rock and of the organic residues left by former vegetation. The four remaining limitations, namely, No. (3) moderate overflow (which means slow surface infiltrability, No. (4) slow subsoil permeability, No. (5) slow drainage, and No. (7) low water-holding capacity, are important physical features mainly depending on soil structure.

(3) Soil Structure

Soil structure is determined by the kind and degree of aggregation of the ultimate texture units of a soil comprising discrete particles of coarse, medium and fine sand, silt and colloidal clay. Without doubt, structure is the most important attribute of a soil and much attention has been given in recent years to its description, differentiation, measurement and origin. Special names have been applied to various kinds and shapes of soil aggregates, and several procedures have been suggested for determining their stability under mechanical attrition when the land is ploughed or harrowed, and under disintegration by water when it is exposed to rain, storms and floods. The most stable soil aggregates are those that are bound together by cementing agents such as organic or inorganic colloidal substances (humus, bacterial mucilage, clay), calcium carbonate and hydrated ferric oxide. Some of the most stable aggregates are cemented by ferric oxide (hæmatite), such as occurs in Tropical Red Soils.

In order to confer desirable physical properties, stable soil aggregates should have a relatively large size (between 4·0 and 0·2 mm.), so that the space between them is relatively large in respect of total volume as well as of actual cross-sectional area. This ensures that root-tips may insinuate themselves between them, and also that water may drain rapidly away after rains. An "ideal" soil would contain about 66 per cent of total pore-space (corresponding to an apparent specific gravity of about 0·90) of which about 33 per cent should consist of pores having a cross-sectional diameter ranging from 2·0 to around 0·07 mm. ("non-capillary" pore-spaces) and 33 per cent of much smaller pores ("capillary" pore-spaces), including the vesicular pores of the micro-reticulum of which soil colloidal matter is supposed to consist.

Coarsely aggregated soils alone conform to this "ideal" specification. In the case of inert sands, only the coarser grades, having particle diameter greater than about 0·5 mm., possess pore-spaces wide enough to permit free and rapid drainage. Coarse sands are so deficient in "capillary" pores, however, that their water-holding capacity is excessively low, their moisture content when fully drained consisting solely of thin films surrounding the sand grains and forming tiny wedges between them, together amounting to only about 20 per cent by weight of the oven-dry material. By contrast, an aggregated colloidal clay soil, when fully wetted and allowed to drain, will retain 70 or 80 per cent of its dry weight of "capillary" water, most of which is firmly held by the colloidal component, though about four-tenths of it is readily extractable by plant roots.

A coarsely-granular, stable surface soil possesses high infiltrability to water and should be able to absorb showers of "torrential" magnitude, that is, over three-quarters of an inch per hour. Rates of penetration less than this would be regarded as "moderately slow" to "very slow"; they would allow water rapidly to fill up the surface soil and

to overflow down the slope. Natural stabilization of surface soil aggregates is usually effected by organic colloidal materials, such as bacterial or algal mucilage or humic residues from decayed vegetation. The aggregates are soft, highly porous and rounded, and are commonly called "crumb".

Below the humic surface crumb, subsoil permeability to water depends on the occurrence of structure units which differ in shape and hardness from crumb, namely, small clods, variously described as cubical ("blocky"), fragmental, nuciform ("nutty"), prismatic, laminar or squamose ("scaly"). These do not owe their formation and stability to organic matter but rather to the kind of mineral alteration products developed over the parent rock.

(4) Soil Structure and Land Capability

It should be possible to gauge the degree of subsoil permeability and the rate of under-drainage (both of which are soil features of the utmost practical importance in Land Capability Classification) by mere inspection of the size, shape, pattern and arrangement of the subsoil structure units and of the interstices between them. This problem is at present receiving intensive study by land capability surveyors of the United States Soil Conservation Service who are attempting to correlate the visual features of the soil profile with the results of actual permeability measurements carried out both in the field and in the laboratory. Authorities are agreed that the most important of all the soil factors affecting crop-growth are those physical features which decide the degree of surface infiltrability (which controls the rate of drainage), the degree of æration, the ease of penetrability by growing roots, the depth of free-rooting soil, the freedom from waterlogging due to fluctuating water-tables, the absence of deep cracking such as favours land-slipping, and the water-holding capacity of the soil. These are all determined by soil structure which should therefore be regarded as the main object of study of the crop ecologist whose chief concern is the evaluation of land capability.

(5) The Origin and Development of Soil Structures

The relationships that occur between different parent rocks and their weathering products, and the kinds of structures which develop in the soils produced from them have received little attention from pedologists, so that the possibility of prognosticating the physical features of a soil from the characteristics of the rock and of the prevailing climate has not yet been fully realized. The natural structures and modes of occurrence of the main types of igneous, volcanic-fragmentary, aqueous-sedimentary, (arenaceous, argillaceous, calcareous and carbonaceous) and metamorphic rocks are well-known and are fully described in textbooks of general geology and petrography. Massive rocks exhibit different degrees of permeability to water because of natural jointing, stratification, lamination, slipping, shattering, slickensiding and cementing, as do also loose volcanic, æolian and aqueous deposits whose component grains show a large range of particle size and widely varying shapes which determine their manner and mode of packing. Percolation of water through rocks is not always vertically downwards; more often it is horizontal or inclined, depending generally on the direction of the bedding planes.

Little is known about the development of structures in the weathering products of different kinds of rocks, but it is realized that climate is just as important a factor as the mineralogical composition of the rock in determining the nature and properties of the end products of mineral decomposition. First consideration should be given to the quartz content of the initial parent rock which may vary widely in particle size and shape as

well as in total quantity. Quartz is regarded as practically indestructible, though liable to comminution by disruption and attrition. Thus it comprises the greater part of most aqueous sediments such as sandstones and loose detrital and coastal sands. Particle size mainly decides the permeability of the weathering products of quartzose rocks such as granites, granodiorites and some syenites, for it has been pointed out above that, unless loose sand grains have diameters greater than about 0·5 mm., the pore-spaces between them when they are in maximum packing are too small to allow the free drainage and adequate aeration demanded by plant roots. Fine quartz sand of particle size between 0·2 and 0·02 mm. packs so tightly that root penetration is difficult and drainage is tardy and imperfect. It is stated that coarse sand (2·0–0·2 mm. grain) is 1,000 times more permeable than fine sand (0·2–0·02 mm. grain), even though it has less total pore-space. The particle size of sand used for the potting of plants and the rooting of cuttings, and for cultivating plants by hydroponics, should be around 0·5 mm. to ensure the best results from constant watering with dilute nutrient solutions. The surface soil that develops over highly quartzose rocks generally consists of loose humic quartz sand having single grain structure, but varying in its water and air relations with particle size.

Particle shape is also important in the case of quartz grains occurring in mixtures of sand and clay for, when the grains are angular and sharp and of different sizes rather than uniform and round, they bind firmly together when compressed in a clayey matrix, and the mass not only strongly resists implemental cultivation but it rapidly wears away the moving steel parts of implements, such as plough discs, as was discovered when the land was being prepared in 1947 for the planting of groundnuts at Kongwa in East Africa.

Rock minerals other than quartz decompose when subjected to the action of natural carbonated water mainly through hydrolysis. The case of the felspars may first briefly be described. The chief end product of hydrolytic weathering is the clay mineral kaolinite ($Al_2O_3.2SiO_2.2H_2O$) formed under fairly humid or semi-humid climates with annual rainfall between 60 and 45 in., and not more than four months' dry season with less than 2½ in. of rain per month. Under a continuously wet climate, however, with rainfall over 100 in. a year, as in British Guiana, gibbsite ($Al_2O_3.3H_2O$) may form directly from the calcic felspars (but apparently not from potash felspar), and this may be re-silicated into kaolinite or halloysite ($Al_2O_3.2SiO_2.4H_2O$) under certain circumstances. These clay minerals do not belong to the shrinking-lattice type; they comprise "lean" clays having low base-exchange capacity. They actually behave like inert fine silt. In association with residual quartz, they are known as "Granite Sand" or "Grey Earth" and have little agricultural potentiality. In the wet tropics, the thickness of the softened rock and the granite sand overlying it may amount to 20 or 30 ft. in some cases. When associated with even small traces of residual ferric oxide, granite sand gives rise to "Yellow Earth", "Brown Earth" and "Red Earth" whose colouration depends on the amount of ferric oxide present and on its degree of hydration. These kaolinic quartzose sandy "earths" may occur in uniform compact masses whose permeability to water mainly depends on particle size. If sufficiently rich in ferric oxide, they may develop a small clod, nuciform or granular structure, whose component units are cemented by dehydrated ferric oxide which imparts a highly permeable, extremely stable structure, so characteristic of Red Earths in the Tropics.

Under a semi-arid climate with annual rainfall between 45 and 30 in. and four to six dry months each with less than 2½ in. of rain, the felspars may give rise to other, more reactive, highly siliceous, highly hydrous clay minerals having expanding lattices

and showing high shrinkage and swelling. These include illite, beidellite and montmorillonite, with silica-alumina ratios lying between 3 and 5, and high base-exchange capacities ranging from 30 to 150 mg. equivalents per 100 gr. Although the conditions of formation of these "fat" clays are not fully understood, it appears that leaching by water must be small, so that alkaline-reacting carbonates and bicarbonates of potassium, sodium, calcium and magnesium, as well as neutral salts such as chlorides and sulphates of these same metals (particularly magnesium), tend to accumulate and to stay in contact with the decomposing felspars.

The occurrence of expanding-lattice clay minerals among the products of weathering of rocks comprising soil parent materials greatly influences their structure. First, they cause the materials to crack conspicuously in various ways, giving rise to structure units of different sizes and shapes. In the case of highly alkaline and saline clays, the cracking tends to be columnar or prismatic. In the case of calcareous materials, it tends to be diffuse, so that the clay breaks up into small angular "nuts" or clods which are very hard, sharp and brittle when dry. Non-calcareous clays, on the other hand, crack irregularly into units whose size seems to depend mainly on the content of sand. In any case, cracking imparts permeability to clays which otherwise, when thoroughly wetted and swollen, would not allow water to move through them at all. Cracks enable roots to penetrate clays and to ramify and produce root-hairs which lie tightly against the walls of the cracks and absorb therefrom both water and nutrients. Water may also move freely, as films along crack walls, from water-tables or wet spots, and so ensure the even distribution of moisture and its uniform delivery to the plant roots.

In course of time, linings and partings of substances that filter into cracks in clays develop and prevent the structure units from coalescing on swelling. Among these deposits are rusty-coloured ferric oxide, black manganese peroxide and white calcium carbonate and calcium sulphate. These substances are presumably precipitated from percolating solutions of salts derived from the upper layers of the soil. Their presence improves the drainage and greatly increases rooting depth.

The markedly stable small-clod and nut structures that characterize the zone of accumulation ("B-horizon") of leached soils in the tropics are mainly developed in parent materials which contain an appreciable amount of expanding-lattice clay minerals. The propensity of these clay minerals for combining with humus which, under alkaline conditions, imparts an intensely black colouration to the organic-mineral complex, accounts for the pronounced coarse crumb structure which their surface layers possess. This feature characterizes Chernozem ("Black Earth"), Rendzina ("Humus-Carbonate Soil"), "Black Cotton Soil", and other Black Clays, (including the Black and Grey Clays and the Plateau Soils of East Africa) that are widespread in the tropics and subtropics.

Certain immature soils formed from volcanic ash of intermediate petrological relationship, under a humid climate, develop highly favourable features because of the fact that the component grains of calcic felspar alter, with appreciable diminution in volume, into pseudomorphs consisting of some allophanoid mineral resembling beidellite. This confers high base-exchange capacity and also high water-holding capacity with an enhanced rate of percolation.

The total pore-space of the altered material may be as high as 80 per cent, of which more than half is non-capillary and mostly comprises large pores. Roots are thus able to proliferate freely within the soil and to penetrate deeply. The ecological conditions presented by these volcanic ash soils are highly conducive to rapid plant growth.

The soils are among the most productive soils known to man. They occur widely in Japan, where they are called *ando;* they also occur in Java, Central America and the West Indies and in many other parts of the tropics and sub-tropics where recent and active volcanoes abound. In the West Indies, they have tentatively been named *Yellow Earth.*

At this early stage of decomposition, the grains of ferromagnesian minerals and magnetite also present in immature volcanic ash soils have decomposed only superficially so that the material presents a "pepper-and-salt" appearance, though stained ochre-yellow by limonitic products of weathering.

(6) Ironstone Concretions

The chief primary mineral components of rocks other than quartz and the felspars are the ferromagnesian minerals, for example, hornblende, augite and olivine. These contribute most of the ferric oxide residues occurring in soils when they are completely broken down by hydrolysis. Soils derived from rocks such as andesite and basalt which are rich in these minerals may contain over 15 per cent of total ferric oxide. This substance not only confers bright red, red-brown and yellow colours on soils, but it also furnishes the source of ironstone concretions which may develop abundantly in highly-ferruginous Red Earths derived from basic igneous and metamorphic rocks. The mode of formation of ironstone concretions within the soil profile is not fully understood. The most generally-accepted theory has been that they are caused by capillary uplift of iron-bearing solutions from water-tables during the dry season and the irreversible precipitation and dehydration of ferric hydroxide therefrom. Against this theory is the fact that ironstone concretions are common in many thoroughly well-drained soils, and they often occur in soil profiles where the water-table seldom rises to near the ground surface. Moreover, the concretions are frequently absent in soils of bottom lands where the level of the water-table is high. Nuclei may be effective in inducing the deposition of ferric oxide but they are evidently not essential. Quartz-gravel layers seem particularly to favour ferric oxide accumulation, possibly because the iron-bearing solutions rapidly become concentrated by evaporation within the wide spaces of the gravel.

Ironstone concretions seem to develop best in the weathering products of highly basic rocks occurring in well-drained uplands, or in the ferruginous residues (*terra rossa*) of impure upland limestones. They take considerable time to form, so that they are characteristic only of mature, senescent or senile soils. The general view now held is that they are formed merely by segregation through migration of iron, and its precipitation and dehydration into ferric oxide from the bulk of the ferruginous weathering products, and that neither capillary uplift nor downward percolation need necessarily be involved in the process.

The ecological significance of ironstone concretions occurring within the soil profile lies in the fact that they may seriously interfere with root penetration, particularly when they form thick layers in which adjacent concretions have coalesced; that they restrict mechanical cultivation, and that they fix large amounts of soil phosphate during their development. When exposed by denudation or soil erosion to complete desiccation, ironstone concretions become indurated so as to form highly resistant superficial layers which stand out in the landscape as hill-cappings, pavements, benches and platforms, giving a mesa-like appearance to the country, as in the case of the Miocene peneplain landscape of Uganda. Ironstone concretions and ironstone gravel are not necessarily

"laterite", because, unlike Buchanan's laterite[1], their formation is not generally attributable to impeded drainage, nor need they necessarily comprise the B-horizon of a hydromorphic soil as does "Ground-Water Laterite" which, according to Marbut's view[2], is the only really "true" laterite.

Certain authorities maintain that ironstone gravel pavements, hardened by exposure following surface-soil erosion (for example, over village sites), may become softened and even disintegrated when natural vegetation re-occupies the site. Dissolution of ironstone gravel washed down into creeks has been reported by geologists in British Guiana. It is indeed necessary to concede that such dissolution actually does go on over peneplains where ironstone gravel pavements are being removed by denudation, for otherwise the gravel would accumulate in vast masses in valleys and estuaries, whereas in fact it is actually sparse in its occurrence in these localities.

1. F. Buchanan. *A Journey from Madras through the Countries of Mysore, Canara and Malabar*, Vol. 2 (London, 1807), p. 440.

2. C. F. Marbut, "Morphology of Laterites", *Proceedings of the Second International Congress of Soil Science* (Moscow, 1932), pp. 72-80.

THE SUNGEI MANIK IRRIGATION SCHEME

By D. S. FERGUSON

BEFORE THE Second World War Malaya found it more economical to buy rice from abroad than to grow her own supply. Since the War all this has changed. The rapid increase in the population of South-East Asia, the disorganization caused by the Japanese occupation, and its aftermath of local insurrection, have reduced the supply of rice exported from Burma, Siam and Indo-China. There is every likelihood that this scarcity will continue, and it therefore behoves Malaya to make herself as independent as possible of foreign supplies. At the moment she produces little more than one-third of the rice she consumes. Thus if the inhabitants of Malaya continue to use rice as a basic item in their diet, the country must either be prepared to buy rice in a sellers' market, or grow sufficient for its needs.

Three methods are being used to help towards filling the rice-bins of Malaya. Two of these methods are designed to increase the yield from existing padi land: (1) the intensive use of fertilizers and the development of high-yielding, pure-strain padi seeds, and (2) the improvement of water control. (3) The third method aims at increasing the acreage of land suitable for padi cultivation. At least 90 per cent of Malayan padi is wet, which means that it is grown on ground covered for part of the year by a few inches of water. This requires a flat terrain, and in Burma, Siam and Indo-China the alluvial plains of the large rivers provide ideal conditions. But in Malaya, with few large rivers, the areas suitable for wet-padi are comparatively restricted. Easily-drained areas with good, clay surface soils have long been cultivated by Malays, and the extensive forested areas, where clay soils underlie layers of peat as much as twenty feet deep, are the only uncultivated areas today. Thus, any large-scale extension of the rice-growing area almost automatically demands a technique for dealing with swamp-jungle on a clay soil under a layer of peat. Experience in the Sungei Manik and Tanjong Karang areas has shown that such land can be drained and irrigated provided the peat is not more than five feet below the surface of the ground. Then over a period of five years the cultivator can destroy the peat by burning it and mixing it with the subsoil. Therefore, the first requirement for a new padi area is flat land with a good clay subsoil not more than five feet below any peat which may have been deposited on it. The second requirement is good drainage to lead off surface water, so that the fields can dry out for the padi harvest. This means that the land must be high enough for the water to run off under gravity into river channels of sufficient size to carry it away to the sea. Drainage by pumping is possible, but adds greatly to the maintenance expenses of an irrigated area, and on the Malayan coastal plains it can usually be accomplished by designing gravity drains to discharge surplus water into near-by river channels at low tide.

The third essential is a supply of water sufficient to inundate the land to the optimum depth for padi cultivation, usually about 9 in. This means that for each acre there must be a daily supply of nearly 10,000 gallons of fresh water which can be diverted into irrigation canals without undue expense. It has sometimes been thought that the lavish and almost daily rainfall of Malaya obviates the need for an artificial water-supply to padi fields, but experience has shown that droughts occur regularly, and may, if they come at a critical period in the life of the padi plant, destroy the whole crop. With an assured supply of irrigation water, the cultivators can time the planting of their crops so

that harvesting can be done when normally dry weather is expected, and also at a time when the crop will not be damaged by monsoon floods. It has been found that a supply of irrigation water ensures not only a better crop than can be obtained by dependence on rainfall, but also prevents occasional total losses. Demands for water for irrigating the padi fields are usually highest during periods of dry weather, but that is when the flow of the rivers is low. Therefore, it is necessary to ensure that the needs of the area to be irrigated are not greater than the river can supply at its lowest.

To illustrate this process of reclamation I propose to describe in some detail the scheme to drain 25,000 acres of land for the Sungei Manik Irrigation Area in South Perak. The Sungei Manik Area is situated between the Batang Padang and Kinta Rivers in Lower Perak. The drainage area forms a triangle, at the apex of which has been constructed the headworks (Fig. 1). Main canals along the northern and eastern sides provide irrigation water, while drainage takes place westwards towards the base of the triangle. Before 1932 it was a jungle swamp, and supported only a few small groups of aborigines. Early in this century agricultural operations for rubber planting had caused silting in the Batang Padang River, which by 1920 was flowing well above the surrounding land. Its waters inundated the country as far as the Kroh and Chikus Rivers, while coarse silt blocked the mouths of its tributaries. With the dispersal of its own waters it could no longer maintain its channel which became so choked with elephant grass that not even a small boat could pass down it. Over 30,000 acres of jungle became almost inaccessible.

Rice had first been cultivated on the banks of the Sungei Manik as early as 1916. In 1922, also, some Banjarese Malays had settled beside an exploratory drain on the edge of the Sungei Manik swamp, and had reclaimed about 500 acres, but the forbidding terrain beyond had stopped further developments. All these early padi fields depended on rain water, supplemented by floods when high tides prevented the free outflow of the Sungei Manik.

Drainage Problems at Sungei Manik

When work began at Sungei Manik in 1931 the Drainage and Irrigation Department was faced with the problem, first of preventing the flood waters entering the swamp, and then of draining it, so that canals and irrigation controls could be constructed to supply water to rice fields where and when it was needed, and to draw it off when it was not required. The irrigation of an area in virgin jungle was a novel undertaking and the engineers had no previous experience of this kind of work to draw on. Moreover, to ensure crops from the first year of occupation, irrigation had to be provided in advance of settlement. The whole of the investigations, therefore, had to be conducted in the swamp itself. Little was known about the area, which was marked on maps as "Jungle and swamp, unsurveyed", so that the first task of the Drainage and Irrigation Department was to survey it. This meant sending survey parties to cut their way through the swamp, and to take levels of the ground along the lines of the paths they cut. It was slow and arduous work. The surveyors were working for days on end knee-deep in water and travel, even along the rentices, was at the rate of one mile an hour. The information contained in the surveyors' field-books was translated into plans, and from these the Design Branch prepared the general outlines of the Sungei Manik Scheme. In all it required about 250 original plans and countless prints. Surveying began in 1931 and continued until 1936 when the final plan was completed, but in the meantime construction work was started on the first stage in 1932.

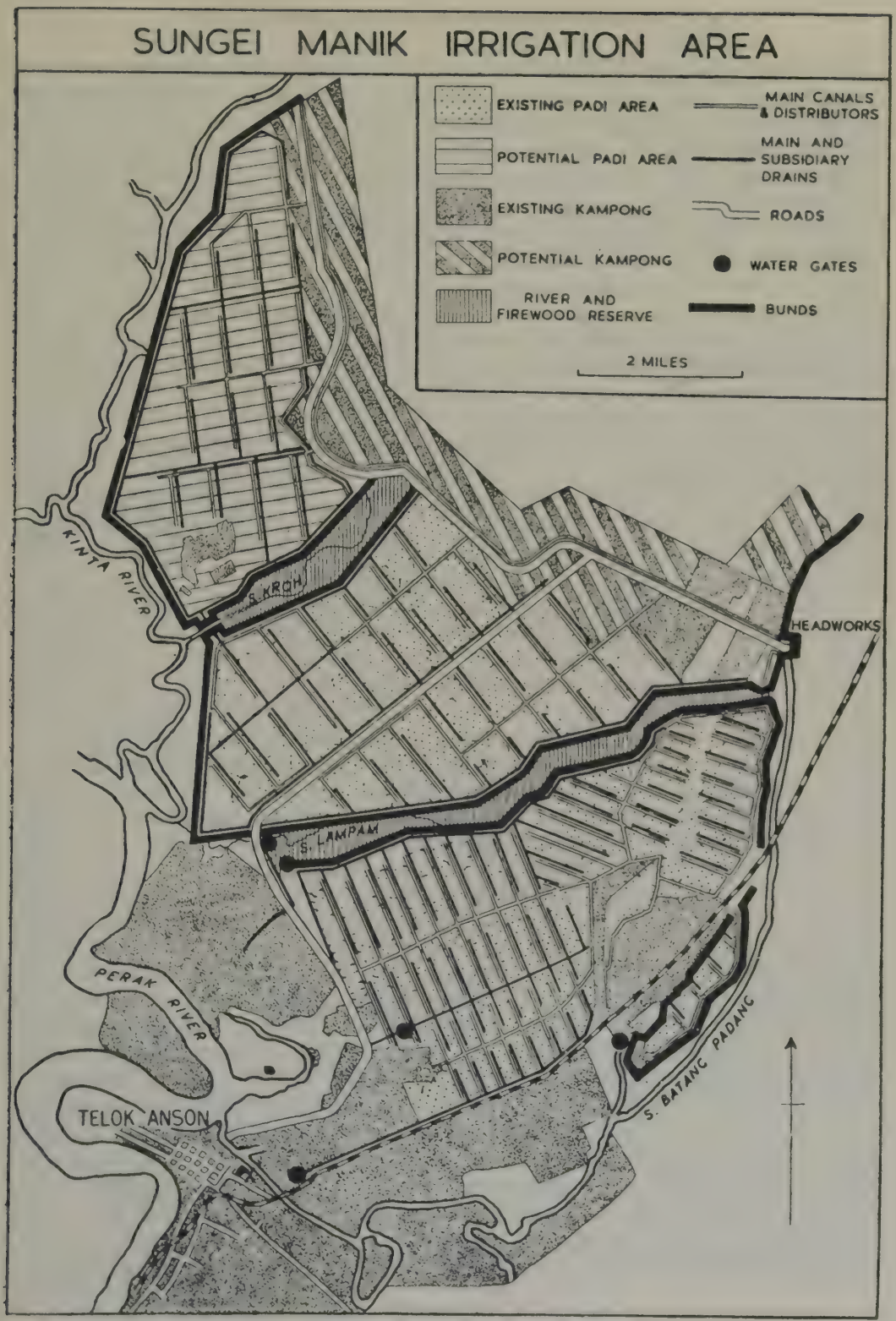


Fig. 1. The Sungei Manik Irrigation Area.
X marks the site of the Government rice mill

When the drainage lines had been opened up conditions improved spectacularly. Access became much easier, and the problem of transporting men, machinery and materials to the working sites was simplified. The next step was the construction of the irrigation canals, together with their headworks and controls. Now an irrigation headworks is usually a major undertaking involving the building of a cross-channel regulator in the bed of the river. To avoid this heavy expenditure at the beginning of the scheme, whenever possible, an irrigation supply was obtained from a temporary headworks serving the smaller areas which were being developed first. At Sungei Manik the available area of 25,000 acres was divided into five stages. The first stage of 5,000 acres was irrigated from a temporary intake on the Batang Padang Mati, a small swamp river; the second from a temporary intake on the Batang Padang River itself; and only after the third stage had been undertaken, was a permanent headworks built on the same river.

While work was in progress on the later stages attention was continually given to the improvement of areas already colonized. In 1938, for example, although the main interest lay in Stages III and IV, improvements were made in the first and second stages. For example, three drainage gates to control water levels were constructed[1]; improvements were effected in the drainage of the exceptionally low-lying Bendang Kroh, which was often flooded in times of prolonged rainfall; and a new drain was constructed from the Kroh outlet gate to the Sungei Tengku, a tidal arm of the Perak River, an undertaking which completely solved this local drainage problem.

The rate of reclamation of the area was dependent on the rate of colonization, and the Drainage and Irrigation Department always endeavoured to anticipate the demand of the settlers for land. If necessary, construction was speeded up to keep pace with this demand. Thus, the uneveness in the rate of development has been due to variability in the demand for land rather than to engineering factors. Stage I soon began to take on the appearance of a well-settled countryside. It is interesting to note that not until water was seen to be flowing in the distributaries did the scheme become popular: the cultivators were quick to recognize the soundness of the project. By 1938 the first three stages were bunded off to insulate them from the flood waters, all the canals, drains and controls had been constructed in these areas, and about 12,000 acres of land colonized.

The outbreak of war in Europe in 1939 saw a quickening of the tempo of activities, and the Perak Government announced its intention of trying to bring all Stage IV into wet-padi cultivation in time for the 1940–1 planting season. Unfortunately the 9,000 acres of jungle in this stage were situated between the Sungei Kroh and the Sungei Lampam, a remote area with no roads or bridle paths, and labour was a difficult problem. The Islamic fasting month was about to begin and the dry season (the time when Malay settlers undertake jungle work) was coming to a close. Moreover, rubber prices were rising and there was little incentive for men to exchange the comfort and security of the *kampong* in which they had lived all their lives for the rigours of jungle clearing in a remote area. Indeed, a team of Malays from Kampong Gajah who attempted to clear part of the area found conditions too severe and had to retire. After this initial setback a rough road and a bridle path were driven through the area, and two villages built, complete with *kongsi* houses, shops, dispensaries, mosques, and wells. After the *Bulan Puasa* the labour force gradually increased in numbers, and by April 1940 more than 2,000 labourers were at work, and jungle was being cleared at the rate of 1,500 acres a month. By the end of 1940 600 men were in occupation of the south-western part of the area,

1. At Sungei Kerawi, Sungei Bakong and Sungei Lampam.

but, in order to allow the settlers to clear their land of stumps, no part of Stage IV was irrigated during that year[1].

So far four stages, totalling 20,000 acres, have been developed and colonized. The fifth stage of about 5,000 acres is said to overlie tin deposits, and the Perak Government has given licences to various companies to prospect the area. Should there be tin in paying quantities, it may be possible to devise a technique for dredging which will not destroy the agricultural potentialities of the land. At the moment, however, prospecting is hindered by bandit activity, so that work has not yet started on the fifth and last stage.

Colonization

The technical aspects of these developments were directed by the Drainage and Irrigation Department, the social and economic aspects by the *Sungei Manik Area Advisory Committee,* under the chairmanship of the District Officer of Lower Perak. The other members were the Raja Muda of Perak, the Assistant District Officer, the Drainage and Irrigation Department Engineer, the Malay Co-operative Officer, the Colonization Officer, the Penghulu, the Agricultural, Health and Land Officers and the Orang Kaya Kaya Laxamana[2]. The Agricultural Officer had varied duties. He distributed seeds, he prescribed the dates of planting in nurseries, of transplanting and of preparing the fields; he checked pests and diseases and measured the yields. He was in charge of the Padi Experimental Station, and, while the land was being cleared, he advised the settlers on catch crops such as dry padi and maize. The Land Officer was responsible for the demarcation of lots within the limits set by the Drainage and Irrigation Engineer, for the collection of land revenue and the registration of titles. He set dates for felling and burning, and for the resumption of land not duly cultivated. In addition, the Forest Department controlled both the disposal of the timber which was felled and also the firewood reserves of the area[3].

Colonization methods were based largely on those which had proved successful in the Punjab, and included propaganda, rigorous selection of applicants, and the grouping together of families from the same locality. In October 1935 a *Colonization Officer* was appointed. But despite these precautions, progress was not always uninterrupted. In 1934 there was a serious decline in the amount of land alienated, due chiefly to the depredations of a herd of twenty-four elephants. These damaged so much property that most of the recently alienated land was abandoned. When the elephants were either shot or driven across the Kinta and Perak Rivers the figures for alienated land began to rise again. In 1937, the padi fields of the first stage were visited by another herd, eight strong, which completely demolished parts of the Lampun Bund and terrified settlers in some of the newly opened clearings. The yields in that year were very poor, too, owing to extensive damage by rats, which found their homes in the uncleared stumps and fallen timber of the *bendangs*[4], and colonization of Stage III was disappointingly slow.

At the beginning of 1939 fees for Temporary Occupation Licences were drastically reduced, and the following scale for land entirely jungle-covered on first occupation was approved by the British Resident.

During the first year of occupation	10 cents per acre
During the second year of occupation	20 cents per acre
During the third year of occupation	50 cents per acre
During the fourth and subsequent years of occupation ..	$1 per acre.

1. If irrigation water is let on to the land before the logs and stumps are cleared, they become waterlogged and take several years to disintegrate.
2. The Malay territorial chief.
3. See Fig. 1, p. 11.
4. The Malay term for *padi fields.*

By the end of March 1939 245 men had taken out occupation licences for land in Stage III, and by the beginning of the planting season the whole area of 1,611 acres had been alienated.

The land settled by the Banjarese had been alienated in lots of three acres, and on these lots the colonists had built their houses, planted fruit trees and were growing their wet-padi. But the general opinion among the settlers was that, once the initial work of jungle clearing, ground levelling and construction of *batas*[1] had been done, three acres of land was not enough to keep a normal Malay family fully employed. Nor at pre-war padi prices was it an economic unit, giving a return sufficient for a reasonable standard of living for the family. The first plan produced by the Drainage and Irrigation Department, therefore, showed lots of four acres. These lots were two chains wide by twenty chains long so that each lot fronted on to an irrigation canal at one end, and on to a drainage canal and an access path at the other. Licences (known as *tambak* licences) were issued under Section 5 of the *Irrigation Areas Enactment* (*Cap.* 145), allowing colonists to use small parts of their lots next to the access path as house sites and orchards. It was found that this lay-out had two big disadvantages. In the first place, the capital cost of irrigation works was expended on a half-acre of land which, as it was used only for houses and orchards, did not need irrigation. Second, for the six months or so of the irrigation season each year the small-holders lived a semi-aquatic life with their surroundings under water. This also prevented the culture of some valuable fruit trees.

It was soon found that the more industrious of the families in the Sungei Manik area could cultivate more than four acres. Some, in fact, were, under different names, already cultivating several lots and producing rice for sale. This was important as it was always intended that these new areas should produce a surplus over the needs of the cultivators in order to help feed the urban population of Malaya. The next step, therefore, was to segregate entirely the homesteads and the padi fields. Four-acre blocks of padi land were alienated, each with another two acres on the nearest high ground. This was held on a tied title, and was to be used as a house site and orchard. Finally, at Stage IV, Sungei Manik land was alienated in lots of six acres for padi only, each with two acres in a *kampong* belt running along the fringe. This total of eight acres is now considered to be an economic unit for a Malay family to cultivate without mechanical aid, and from which to gain a livelihood. The six-acre padi lots are three chains wide by twenty chains long, with one frontage of three chains on to either a drain or an irrigation canal.

The main disadvantage of this method employed in Stage IV is the long interval between the completion of the irrigation works, which is when the colonists enter into their holdings, and the time when the full six acres of land is cleared and cultivated. In future development schemes it may be possible to drain the land, fell and clear the jungle, and settle the small-holders before irrigation is provided. The colonists can then cultivate dry crops for the first few years, which means that irrigation water need not be supplied until all the land is ready for cultivation.

The Malay settlers found the work very arduous during their first few years. They had to build houses, fell and burn the jungle, dig out the roots, and construct *batas*. It has been estimated that the felling and clearing of a six-acre lot represents four years' work for a single settler without help. At the same time the colonists had to earn their livelihood, but the area they could plant at first was not sufficient for this, so several means of supplementing their incomes were devised. It was not always possible to employ them on construction, but the irrigation and drainage works were maintained

1. *Batas* are the narrow, earth embankments constructed on padi land to retain and distribute water.

wholly by *bendang* owners. The work was so organized that each settler was employed for only twenty days each month, which enabled a large number of men to be employed, with a consequently wide distribution of wages. Moreover, this work lay close to the kampongs. This was important as, to supplement their incomes, many of the settlers would otherwise have had to find work outside the area, and this would have reduced the time devoted to their own *bendangs,* and thus have retarded the development of the area as a whole.

Towards the end of 1934, and again in 1935, the drains of the area were stocked with the fry of *Sepat siam* (*Trichogaster pectoralis*), a small fish imported from Krian. These breed in profusion in the flooded rice fields, and survive the dry season in sump pits. Towards the end of the irrigation season, when draining-off begins, as much as ten or fifteen piculs of fish are caught in a day. They can be sold fresh or sun-dried, and having an oily flesh, are very acceptable with rice. They also provide a very useful subsidiary source of income for the *bendang* owners who sell them alive to Chinese agents, who in turn market them in Ipoh, Kampar, Tapah and Teluk Anson. In 1937 the fish exported from the Sungei Manik Area sold for M$5,000, in 1938 for M$20,000. There are no post-war figures available, but the *Sepat siam* fishing industry is still thriving.

The settlers were also allowed to cut, free of duty, from the adjacent Forest Reserves, both timber for house construction and rattans. These latter can be used to make baskets, *bubus*[1] and *tempangs*[2], but can also be sold easily, and thus provide another source of income.

Since the war, the Government has been offering certain financial inducements to settlers in new areas. These are a subsidy of M$50 for each acre of jungle felled and cleared, a free supply of pure-strain padi seeds in the first year, and free tools and materials for house-building. In addition, the Government has constructed access roads, built schools and dispensaries, and now plans to provide fresh water for domestic use.

The Government reserved a site for a rice-mill on the river bank, near to the road and railway, at Teluk Anson (Fig. 1), and in 1940, as soon as the quantity of surplus padi justified it, a mill was erected, together with permanent godowns, drying fields, various necessary ancillary buildings, roads, light railways, a wharf for lighters and quarters for the staff and mill hands. The mill has an output of eighteen bags of white rice per hour, together with by-products which are valuable as poultry and cattle food. To this mill the people can bring their surplus padi by road or rail or water, for sale at the mill door at a minimum price fixed by the Government. The mill is operated as a non-profit-making concern by a Board of Managers on behalf of the Government.

In 1937 a weekly fair was instituted at Jalan Permatang. Hitherto, a *bendang* owner had to travel to Teluk Anson to sell any surplus produce. If he failed to find a purchaser he was faced with a complete loss, while the train journey had to be paid for with cash. Not only did the weekly fair obviate such losses of time and money, but it also provided a method whereby the *bendang* people could assist one another by barter if ready cash was not available. The usual commodities on sale were *kutch Melayu*[3], mats, baskets, reaping knives, fruits, vegetables, *changkul*[4] and *tajak*[5] handles. So successful was this fair that a second was started in 1938 at Chikus. In addition the weekly

1. A basket-trap for fish.
2. Another type of fish trap.
3. An astringent extract from the wood of several species of acacia.
4. A type of hoe used for digging and breaking up earth.
5. A grass-cutting tool.

fairs provided an opportunity for *bendang* owners and the various officers concerned with Sungei Manik to meet together and discuss problems of common interest.

The Advisory Committee have planned the development of the area as a balanced unit where the colonists can gain a fair livelihood and enjoy a healthy life. It is the intention of the Government of the Federation to continue this development so that the people, while producing rice for sale to the mills, may be able to enjoy the social services which the Government of any modern state should provide. In this way it is hoped that the drift from the land, so apparent in Malaya, in the first half of this century may be halted. The population of the Sungei Manik Area was about 1,500 in 1932, 6,000 in 1938, 10,600 in 1947, and has now reached about 15,000. That is, a tenfold increase in twenty years. Not very impressive, perhaps, but it does mark a local reversal of the general trend.

RECENT DEVELOPMENTS IN NIGERIAN PEASANT FARMING

By KEITH BUCHANAN

RECENT POLITICAL developments in Africa have tended to divert attention from the more fundamental economic problems which are arising out of the growing instability of African peasant agriculture. The causes of this instability vary from territory to territory, but two are outstanding: the gradual growth of population as a result of improving health conditions; and the extension of cash cropping to meet the growing demand of urban populations, to supply the urgent world need for tropical products, and to produce the revenue necessary for all social and political progress. These trends result in an expansion of the cultivated area, a reduction in the length of regenerative fallows, and a gradual decline in the level of soil fertility, leading in extreme cases to actual physical destruction of the soil by erosion. Nowhere are these developments more clearly to be seen than in Nigeria, where some of the densest agglomerations of rural population and some of the most specialized crop economies in Africa are to be found. Here, in recent years, a wide range of pilot projects has been undertaken in an attempt to integrate methods of crop production and processing into the traditional framework of peasant agriculture, and to tackle the problem of unbalanced population distribution by schemes of controlled settlement and internal colonization.

THE GENERAL SETTING

Within an area of 372,000 square miles Nigeria offers a comprehensive cross-section of tropical environments, and an understanding of these is a necessary prelude to successful agricultural development. Relief is rarely of major importance in the Territory[1], and the pattern of human activity is dominated by the great climatic and vegetation belts which run from east to west across the country. Recent mapping distinguishes nine major belts, but from the agricultural point of view these may be grouped into three categories: the high forests of the south, the Guinea savannas of the Middle Belt and the Sudan savannas of the extreme north (Fig. 1).

High forest is the climax vegetation of the humid southern sector. Most of this region has a rainfall exceeding 50 in. (Fig. 2A) so that the soils of the area are heavily leached, and the combination of heat, shade and high humidity throughout much of the year provides ideal conditions for the tsetse fly and the malarial mosquito.

Excluding the mangrove and swamp-forest of the coast belt, the high forest falls into two major regions: the rain forest of the humid east and the dry forest of the west. The former is an outstanding example of a region of difficulty, an area of tangled rain-sodden vegetation, and of intensely leached, sandy soils whose acidity renders them useless for all save a limited range of crops. Yet the density of population here locally exceeds 1,000 per square mile. This great concentration of population in an environment

1. The exceptions are the Cameroons Mountains and parts of the Niger delta and Jos Plateau.

which originally must have had few attractions to the farmer constitutes one of the major paradoxes of Nigerian geography. Here, the intense pressure of population, leading to over-cultivation of initially fragile soils, has resulted in soil erosion and depletion on a large scale.

Westwards, with decreasing rainfall, the rain forest gives place to dry forest, still multi-storied in character, but containing a higher proportion of deciduous trees. The soils in this dry-forest region are derived from the gneisses and granites of an old shield, so that they contain reserves of fertility which are completely lacking in the leached soils derived from the sandstones of the eastern rain forest, and this has undoubtedly been a factor of major importance in the rise of the prosperous peasant communities of the Yoruba country.

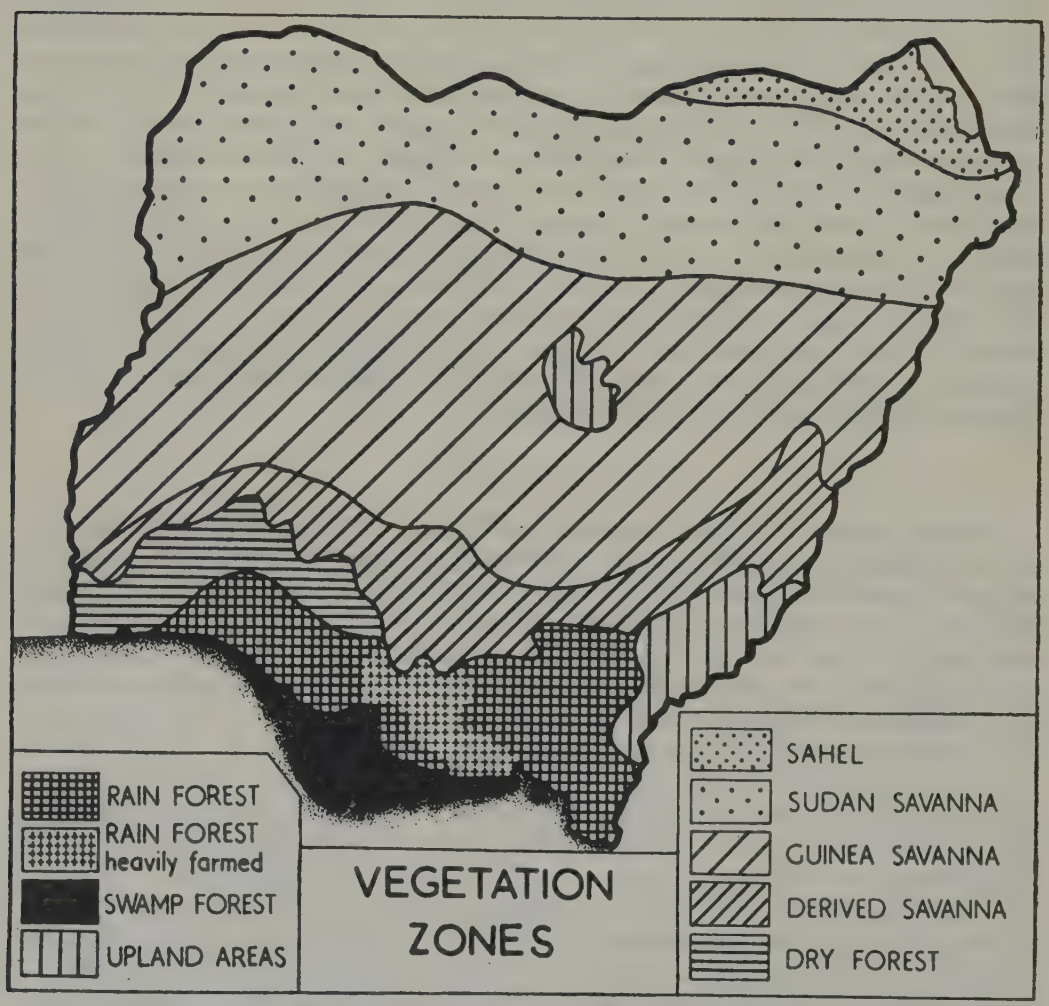


Fig. 1. Vegetation Zones. Note (1) the relatively restricted extent of rain forest; (2) the extensive area degraded by farming in the Ibo country; and (3) the recession of the northern edge of the high forest suggested by the broad belt of derived savanna. The Guinea and Sudan zones offer the greatest scope for the development of mechanized cultivation, but in the southern high forest, by contrast, the plantation will be the main form of pioneer development.

The small, unshaded area in the north-east represents the Nigerian sector of Lake Chad.

The climax vegetation of the Middle Belt consists of broad-leaved, savanna woodland, degraded by firing and felling to open, tall-grass savanna with twisted, fire-scarred trees. Over much of the Middle Belt soil conditions are less favourable than in the dry forest or the northern plains, rainfall is highly variable, water supplies are difficult, and the whole area constitutes a relatively thinly-peopled no-man's land between North and South. Its wilder and rockier parts, especially the Jos Plateau, have played an important role as refuge areas for primitive peoples, but its more favoured parts, often scantily peopled for historical reasons, constitute one of the most important pioneer settlement areas in Nigeria.

The Sudan savanna zone of the extreme north has played a more positive role in the agricultural development of the Territory. Its typical vegetation consists of open savanna woodlands. This Nigerian Sudan zone is characterized by open, elevated plains, veneered with sandy drift which gives rise to easily worked, productive soils. Rainfall is low and is confined to the summer season. This has an important bearing on the agricultural economy, for in the absence of irrigation, cultivation is based on annual crops. Moreover, the absence of the tsetse fly (as a result of the heat and aridity of the dry season) permits the rearing of cattle on a scale impossible in the more humid Middle Belt or South. As in the Middle Belt, water is an important limiting factor, and the close settlement and highly developed economy of the Kano area is largely a reflection of the improved water supplies in this central sector of the Sudan zone[1].

Superimposed on, and often showing little relation to, this varied environmental setting is a complex pattern of settlement and human occupance. The Territory is one of the most densely populated countries in Africa, with 28 million people and an average density of 60 per sq. mile, but it shows an extremely patchy population pattern. In parts of the Middle Belt population densities drop below five per sq. mile, and large areas are virtually uninhabited. In the Kano district, on the other hand, densities locally exceed 500, and in parts of Iboland they approach 1,000. Three regions, the Kano area, Yorubaland and Iboland, have two-fifths of the total population on only one-seventh of the area of the Territory, while the Middle Belt, by contrast, with two-fifths of the area of the country, supports less than one-fifth of the population. Environmental conditions have clearly played an important role in the evolution of the general population pattern, but they alone do not explain its extreme patchiness. The present-day population pattern is only intelligible in the light of the history of the area, notably past slave-raiding and internal wars which depopulated vast areas of fertile land and brought about defensive concentrations of population in and around the walled cities of the Sudan zone, in the shelter of the southern rain forest, and on the boulder-littered hill tops of the Middle Belt and Cameroons. This is of some importance in the agricultural economy of the Territory for, as these pressures are relaxed, the old pattern of settlement is tending to break down, and uncontrolled migration and settlement are destroying both vegetation and soil. It is against this background that the growing official interest in schemes of controlled population redistribution and planned land-settlement should be viewed[2].

1. Further information on these environments is contained in R. W. J. Keay, *An Outline of Nigerian Vegetation* (Lagos, 1949); H. Vine, "Soil Resources for Increased Production", *Farm and Forest*, Vol. 9, No. 1 (Ibadan, 1948), pp. 21-7, and "Nigerian Soils in Relation to Parent Materials", *Commonwealth Bureau of Soil Science, Technical Communication No. 46* (London, 1949).

2. For a discussion of population distribution see K. M. Buchanan, "The Northern Region of Nigeria", *The Geographical Review*, Vol. 43 (New York, 1953), pp. 451-73.

Finally, no account of the environment of Nigeria is complete without reference to the factor of disease. The Nigerian inherits almost all the diseases of temperate regions and escapes the others only by dying relatively young. In addition he suffers from a multitude of diseases to which ignorance, poor standards of hygiene and the humid tropics render him susceptible. The Sudan zone is the zone of epidemic cerebro-spinal meningitis, relapsing fever, undulant fever, and typhus; the southern high forest is the zone of yellow fever, malaria, leprosy, and filiarasis. The disease pattern of the Middle Belt, the transition zone between these two regions, includes both southern and Sudan elements but is dominated by endemic sleeping sickness (Fig. 2B).

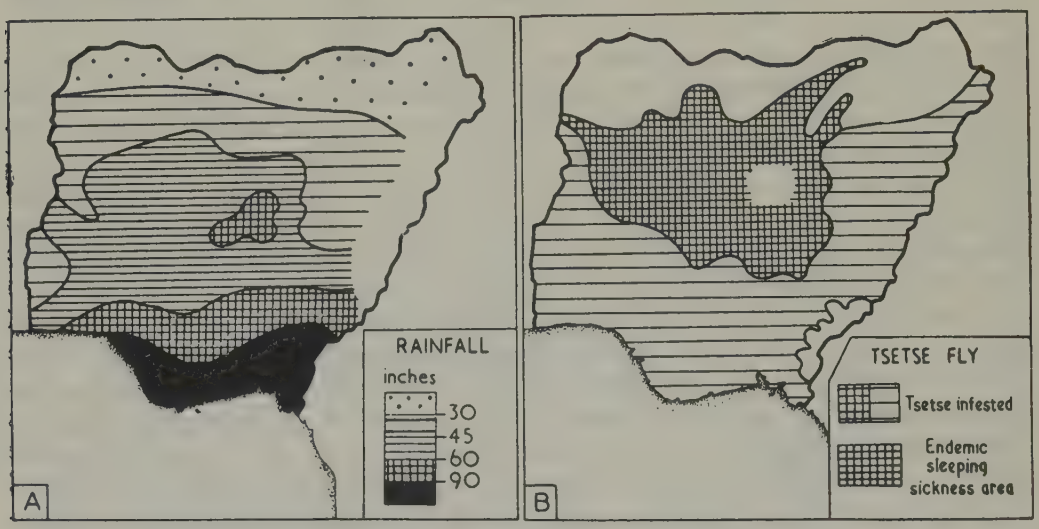


Fig. 2.

A. Rainfall. Note that the northward decrease in annual precipitation is accompanied by a sharp decrease in the length of the rainy season. In the Sudan zone this short duration of the wet season is of major importance in all development schemes.
There are insufficient data from the Cameroons highland to complete the eastern sector of the map.

B. Tsetse Distribution. Four-fifths of the Territory is tsetse-infested and, until successful methods of large-scale immunization are perfected, rearing of the larger types of stock is impossible in this area. Note that though the fly is prevalent over the whole of the southern forest zone, and though *nagana* (animal trypanosomiasis) is widespread, human sleeping sickness is rare.
The fly-free region of the Jos Plateau is represented diagrammatically.

It is impossible to over-estimate the importance of disease in the social geography of Nigeria. Malaria, a preventable disease, is responsible for one-tenth of the deaths among young children and for a vast amount of ill-health among adults. Infestation with intestinal worms saps the energy of the peasant and, since it is at its maximum in the wet period, it causes a wastage of labour at the peak season of agricultural demand. Some four-fifths of the Territory is tsetse-infested and the prevalence of sleeping sickness goes a long way towards explaining the scanty population and low level of economic

development in the Middle Belt. Further, the presence of the tsetse fly at present prohibits the rearing of the larger types of cattle over much of the Territory, with the result that mixed farming is impossible, transport away from the roads must rely on human carriers, and the peasant, because of a shortage of meat and milk, suffers from multiple nutritional deficiencies which limit his productivity and predispose him to disease. In the expansion of peasant farming in the Tropics the contribution of the doctor is as vital as that of the plant breeder or the veterinary scientist.

The Indigenous Agricultural Economy

The indigenous system of agriculture is often referred to as *shifting cultivation;* it is more accurately termed *bush fallowing* or *field-forest rotation.* Its typical features may be summarized thus: the farmer selects an area of forest or bush, clears the undergrowth, and cuts off the smaller trees and shrubs some two or three feet above the ground. Useless trees are killed by piling dried undergrowth around their bases and firing it; the plot is then cultivated for from one to three years and left fallow for a period ranging from five to fifteen years, during which the bush regenerates and fresh land is brought into cultivation. This system has several advantages; it utilizes the ephemeral fertility of the soil, a fertility increased by the wood ash from the burning of the slash; the small size of the typical forest-girt plot is a safeguard against erosion; and labour requirements are reduced to a minimum by the use of fire and by leaving the larger stumps in the ground. It is, in short, a system which, to quote E. B. Worthington, "is admirably adapted to the needs of primitive peoples, provided there is sufficient land available[1]".

This latter proviso is of vital importance, for once pressure on the land is intensified as a result of an increase in the acreage under either cash crops or the subsistence needs of an expanding population, then the period of fallow is shortened, the vegetation does not regenerate and a downward spiral of soil degradation commences. The critical density of population above which over-cropping is inevitable naturally varies according to environmental conditions. In the high-forest zone of Southern Nigeria, Professor Stamp has estimated that this critical density is 144 per sq. mile[2]. It is significant that over large areas the density exceeds 200 per sq. mile and that locally it rises as high as 1,200 per sq. mile. Under such conditions the collapse of the agricultural economy is inevitable unless a drastic re-orientation of the existing methods of production can be carried out. This is the fundamental background to all agricultural development in Africa today.

The Scope and Character of Development Projects in Nigeria

The geographical diversity of Nigeria rules out the possibility of any single solution to the Territory's agricultural problems, while an inadequacy of data regarding environmental conditions has precluded the initiation of large-scale development projects comparable to the East African groundnuts project or the Gambia poultry scheme. A solution is, therefore, being sought through a wide range of experimental pilot projects distributed so as to cover a wide range of environmental conditions. (Fig. 3).

1. E. B. Worthington, *Science in Africa* (London, 1938), p. 377.
2. L. D. Stamp, "Land Utilization and Soil Erosion in Nigeria", *The Geographical Review*, Vol. 28 (1938), p. 35.

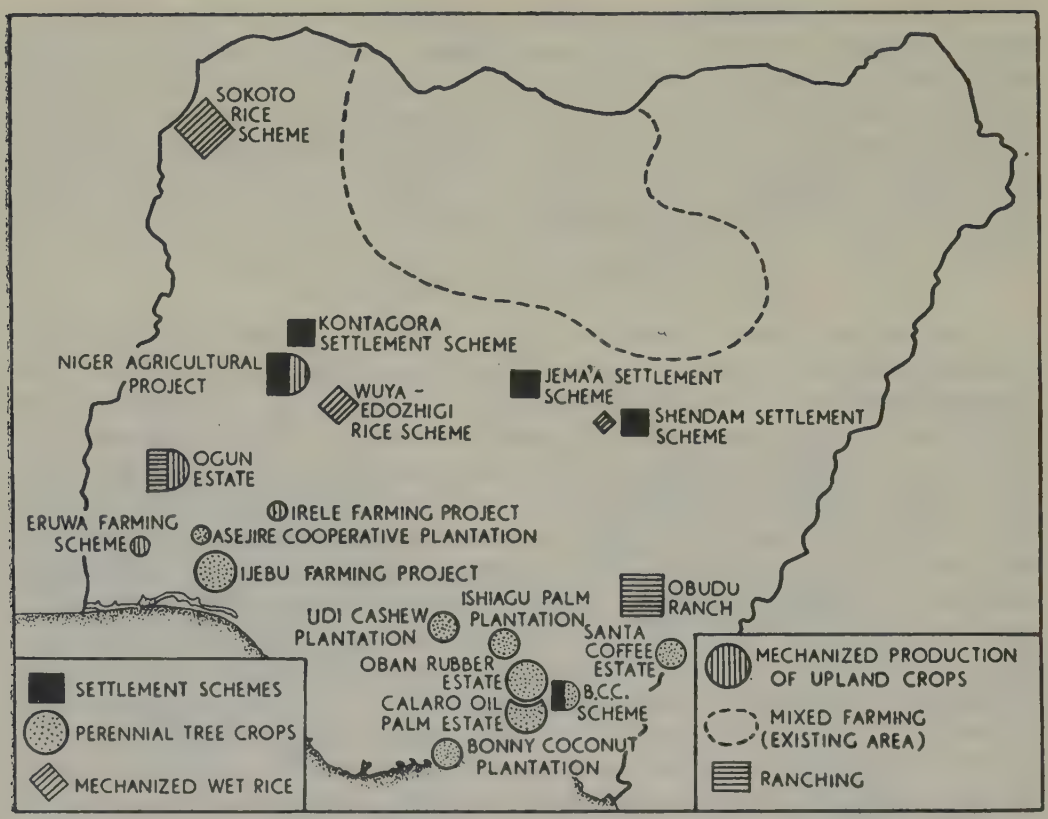


Fig. 3. Development Projects. With the exception of mixed farming, which was introduced into the central Sudan zone some twenty years ago, these projects have all been initiated in the last seven years. Note the concentration of settlement schemes in the Middle Belt, and of projects based on perennial tree-crops in the southern high forest. Note, too, the absence of development in the pioneer fringe of Bornu.

The size of the symbols varies according to the importance of the projects.

(1) *Schemes of Planned Resettlement*

Because of the extremely patchy distribution of population there would appear to be considerable scope for planned internal colonization designed to move people from congested areas to less closely settled parts of the country. Today, three main pioneer-fringe areas may be distinguished in Nigeria (Fig. 4).

(1) Parts of the high-forest country of the south, especially in Calabar Province.

(2) Parts of the Middle Belt, e.g. in Niger and Benue Provinces.

(3) The north-eastern sector of the Sudan zone, an area corresponding broadly with Bornu Province.

When considering the possibilities of a large-scale, planned redistribution of population three points may be stressed. First, if the reception area is already thinly peopled, the integration of the immigrant groups into the existing fabric of society is a major problem of social engineering. Second, for the present it is probably desirable to channel migration latitudinally, so that migrants move from east to west, that is, within the

major climatic and vegetational zones. Quite apart from the political difficulties that it would entail, large-scale migration from south to north is unlikely for many years to come for the simple reason that the farmer of the southern rain forest is culturally not equipped to cope with the agricultural problems of the sub-humid north. Third, our knowledge of the potentialities of Nigeria's empty quarter is so small that existing resettlement schemes must inevitably be of a pilot character. Moreover, the inadequacy of

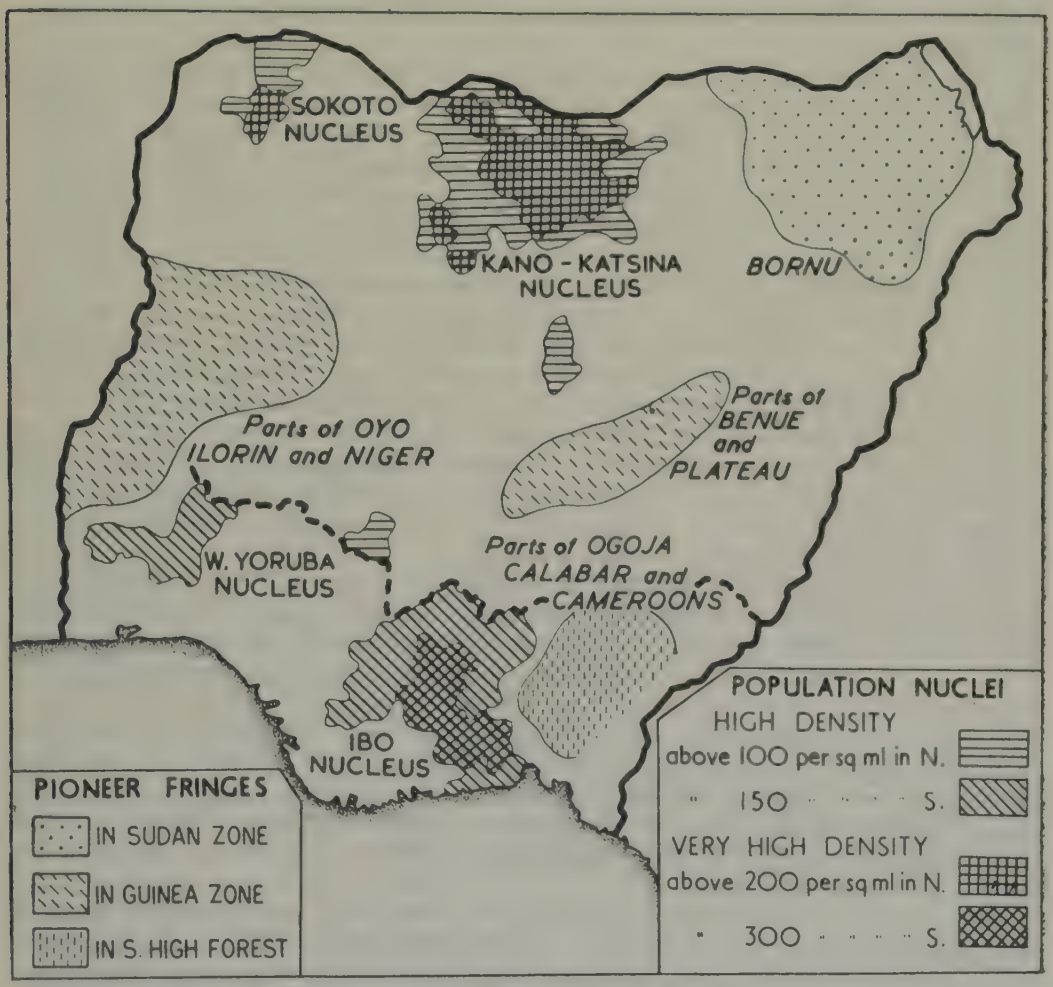

SOKOTO NUCLEUS
KANO - KATSINA NUCLEUS
BORNU
Parts of OYO ILORIN and NIGER
Parts of BENUE and PLATEAU
W. YORUBA NUCLEUS
Parts of OGOJA CALABAR and CAMEROONS
IBO NUCLEUS
PIONEER FRINGES
IN SUDAN ZONE
IN GUINEA ZONE
IN S. HIGH FOREST
POPULATION NUCLEI
HIGH DENSITY
above 100 per sq ml in N.
" 150 " " " " S.
VERY HIGH DENSITY
above 200 per sq ml in N.
" 300 " " " " S.

Fig. 4. Areas of Dense and Sparse Population.

This map depicts—

(1) The four major areas where population is pressing heavily on land resources. A density of 80–100 per sq. mile may be regarded as the maximum that a system of bush fallowing can support without curtailing fallows in the savanna zone. In the high forest, owing to a longer growing season and more rapid regeneration of the plant cover, the critical density is of the order of 140–160 per sq. mile.

(2) Three major types of pioneer fringe, each with contrasting potentialities: (i) thinly peopled high-forest country suited to plantation development; (ii) parts of the Guinea savanna belt, suited to settlement schemes based on annual crops; (iii) fly-free, open savannas of Bornu, suited to ranching, to peasant mixed farming based on grains and oil-seeds, or to large-scale mechanized production. There is insufficient data to determine the precise boundary of the pioneer area of the south-east.

the road network has meant that one of the most promising areas, in the Chad Basin, has so far been largely neglected.

There are at present two schools of thought regarding settlement[1]. The first is based on the conviction that men cannot be permanently helped by doing for them what they could and should do for themselves; and in settlement schemes motivated by this belief, only the absolute minimum is done for the settler. The second school of thought emphasizes heavy capitalization to produce rapid results, so that the settler can discharge his debt within a few years.

The first approach is represented by the *Shendam Agricultural Development and Resettlement Scheme,* designed to control the downhill migration of Pagan farmers and to promote the agricultural development of the thinly peopled Shendam area. The project is designed to control population movement by the progressive establishment across the main line of advance of groups of villages to which migrants can be directed. These villages are established by communal self-help and each accommodates between forty and seventy settlers with their families. Each settler receives twenty acres of land, of which it is proposed to use one-third for food crops and two-thirds for cash crops. Each village has its own grazing land and communal forest area at the rate of forty acres for each settler. Cropping is based on a system of rotation and manuring drawn up by the Agricultural Officer, and erosion control is ensured by grass strips along the contour. Small areas of *fadama*[2] offer potentialities for rice-growing. Large-scale mechanized production is being developed in the Shemankar Valley on the western boundary of the settlement area. The improvement of communications has been an essential part of the scheme and so, too, has control of disease, for this is an endemic sleeping-sickness area. If plans materialize on schedule, 30,000 people will be settled in 94 villages at an average cost of £4 per head.

The second approach is illustrated by the *Kontagora Native Authority Land Settlement Scheme*[3] which was initiated in 1948 to develop under-populated areas in Kontagora Emirate in Niger Province. The project aims at establishing fifteen settlements by 1954, each of twenty farmers and their families. Holdings will average 35 acres, of which half will be fallow, and each will be cultivated with the aid of a plough and cattle. The main crops will be guinea corn and groundnuts, with the possibility of irrigated production of sugar and vegetables on alluvial stream-side land. The scheme is financed by the local Native Authority which is advancing £250 per settler for the clearing of the land by paid labour and for the purchase of livestock and equipment. Additional assistance for the provision of buildings and services has been given by the Regional Production Development Board.

In contrast to these schemes based on the cultivation of annual crops in areas of open savanna woodland, is the *Bamenda-Cross River-Calabar (B.C.C.) Scheme*[4], a project of planned settlement in the southern forest zone, based on perennial tree crops. The scheme was designed to test the possibilities of a planned redistribution of people between the over-populated areas of Iboland and the empty forest country in eastern Calabar. The main settlement consisted of some 5,900 acres and was to accommodate 200 families; its economy was to be based on a thousand-acre plantation of oil-palms and on the cultivation of the basic food crops. Each settler was to receive seventeen

1. See E. O. W. Hunt, *An Experiment in Re-Settlement* (Kaduna, 1951); and "Operation Re-Settlement", *Nigerian Marketing and Regional Production Development Board's Journal,* Vol. 1, No. 2 (Lagos, 1952).

2. Seasonal swamp.

3. See the *Second Annual Report of the Northern Regional Production Development Board,* 1950-1 (Kaduna, 1951), p. 10.

4. See the *Second Annual Report of the Eastern Regional Production Development Board,* 1950-1 (Enugu, 1951), pp. 10-12.

acres of land: two acres for his house and compound, ten acres for food crops, and five acres of oil-palms. These last were to be maintained by the settler and leased to him when the palms had reached bearing age, that is, after the fourth year. In addition, provision was made for cash advances of up to £60 to assist settlers to establish themselves. The initial clearing and the planting of palms was done by paid labour. This scheme has achieved only a moderate degree of success, and in 1950 a radical modification was decided upon. The scheme was divided into two parts: an Eastern Area, where some 115 settlers are established, will remain under the control of the B.C.C. Authority, while a Western Area, of approximately 3,000 acres has been leased to the East Regional Production Development Board for development as an oil-palm plantation. The number of settlers in the Eastern Area is to be stabilized at its present level and the economy of the reduced settlement scheme is to be strengthened by the development of 500 acres of surplus land as a palm plantation. The total cost of establishing a settler, exclusive of advances, has been £240 (i.e. ten times the cost of establishing a family at Shendam). The reasons for the limited success of the project are complex. They include a rise in costs during the last few years; inadequate supervision; the failure of the settlers to maintain the palms, whose maintenance thus became a charge on the Authority; and the opportunism of many settlers "anxious to get rich quickly and .... keen to stay in the schemes only so long as cash advances were made to them[1]".

It is probably in this matter of peasant attitudes that the explanation of the contrasts in success between the Northern Region schemes and the B.C.C. scheme should be sought. It is true that perennial tree crops do not represent as satisfactory an economic basis for pioneer tropical settlement as do annual crops, and that little use can be made of mechanization in high-forest country. Even more important, however, is the desire for quick riches which is so widespread among some of the more Westernized southern peoples, and which may well prove a major obstacle to long-term agricultural development plans in the South. In this connection it is perhaps not without significance that the Southern Regional Production Development Boards are showing a growing interest in the plantation system as a method of improving under-developed areas.

(2) *Schemes of Large-Scale Mechanized Cultivation*

The development of mechanized cultivation is widely regarded as a solution to many of the problems facing African agriculture today. According to this view, the African peasant can pass directly from his traditional hand techniques to mechanized farming. The argument is attractive, for mechanization would appear to have many advantages in an African environment It would greatly increase the productivity per worker and enable vast tracts, now thinly peopled and under-developed, to produce, relatively cheaply, large surpluses for export or for the internal market. It would make the peasant farmer more mobile, enabling him to cover a larger acreage in a given time or a given acreage in a shorter time. The increased speed of cultivation and harvesting would be particularly important in areas such as the savanna lands, which because of their rainfall regime have a limited growing season, and would make possible an expansion of cropping into areas at present climatically marginal. At the same time, it would enable the farmer to overcome the handicap of delayed planting, whether as a result of excessive precipitation or the late arrival of the rains.

These are important considerations and their validity has been demonstrated in climatically marginal areas in both the New World and Australia. At the same time, it should be emphasized that mechanization in a territory such as Nigeria raises problems

1. Idem., p. 11.

quite different from those encountered in temperate regions. These problems fall into three broad groups: (i) technical engineering problems; (ii) agricultural problems; and (iii) problems of land tenure and human attitudes.

On the technical side the problem may be summarized briefly. "Experience in the use of tractor-drawn implements is lacking throughout the whole of the Tropics. Few implements have been designed specifically for the cultivation of tropical food-crops, and certainly none for two of the main staples of the region, cassava and yams. There is little doubt that engineering skill is capable of devising suitable types of implements and tractors required for a wide range of annual crops and that some degree of mechanization is possible for the cultivation of biennials. On the purely engineering side, however, success will largely depend on the efficiency of the organization responsible for the maintenance and servicing of machines and equipment. Whilst alive to the sales side, private enterprise appears indifferent to the need for an adequate repair service and is unlikely to provide a service network similar to that enjoyed by farmers in the United Kingdom. The required organization will represent a very substantial expenditure of capital, and until such a network of repair facilities exists throughout the country there can be little hope of rapid expansion, or for the individual operator to embark on tractor cultivation"[1]. In this connection the importance of the human factor must be stressed for while the African can be trained to become a tractor driver or machine operator in a very short time, he is notoriously heavy-handed with equipment and indifferent to its maintenance needs.

Equally important is the problem of fertility. Mechanized cultivation means open and permanent cultivation, and necessitates clearing of the forest or savanna vegetation and stumping of the land. It thus becomes essential to devise some method, other than the traditional restorative fallow, of restoring and maintaining soil fertility. Grass fallows, as used in East Africa, may meet this need, especially if supplemented with artificial fertilizers; but until further long-term experiments have been carried out no final answer is possible. The use of farmyard manure has been shown to be one answer to the problem of maintaining soil-nutrient status under widely contrasting conditions in Nigeria, but, unfortunately, over much of the Territory tsetse infestation rules out large-scale cattle husbandry, and hence the use of animal manure.

Third, there are the social and economic problems. Large and compact holdings are a necessary prerequisite to mechanized cultivation, and in this connection the traditional African pattern of small, scattered holdings is a major obstacle to development. Consolidation of holdings under some form of group farming is essential, but how far such an agricultural revolution is likely to be acceptable to the peasant farmer is problematical. Further, to what extent such a system would be workable in view of the very patchy distribution of good land in many areas has yet to be demonstrated, but several existing pilot schemes should yield much-needed data on this point. Moreover, it must be stressed that if mechanization is to represent an advance on the traditional systems of farming, its productivity must not only cover operating costs, interest and depreciation, but also yield a substantial surplus over the older methods. Here two points must be stressed. First, the substitution of machinery for hand labour means the replacement of costly by cheap factors of production. Second, owing to climatic and soil conditions, the use of machinery is practicable only for relatively short periods of the year—in Northern Nigeria for some three or four months—while for the rest of the year it is virtually prohibited. Long-term investigations are clearly necessary to work out the economics of the system. As the Groundnuts Project showed, Africa imposes its own pace

1. *Third Annual Report of the Western Regional Production Development Board*, 1951-2 (Lagos, 1952), p. 16.

of progress which we of the West must accept. A wide range of experimental schemes and pilot projects has been initiated and these have shown that the problems of mechanization of upland farming are many and formidable, and that it would be unwise to be too optimistic regarding the scope for development in this direction.

More promising results have been achieved with mechanized rice cultivation on the fertile *fadamas* of the Northern Region. In Sokoto Province the use of tractors and heavy implements has made possible the cultivation of considerable areas of seasonal swamp, which in the past have been left uncultivated because of the difficulty of tilling the clay soils by hand[1]. Heavy D7 Caterpillar Tractors were necessary for ploughing and, in spite of difficulties, the goal for 1951–2 of 25,000 acres was achieved, and an expansion to 40,000 acres is expected with confidence. The land is pooled for ploughing and subsequently redistributed for sowing by the local authority. Much of this land was formerly used as seasonal grazing by the Fulani, and its cultivation has created a minor problem of some delicacy. The small-scale scheme for mechanized rice cultivation at Shemankar has been referred to earlier[2]. This scheme differs from the Sokoto scheme in two respects: soils are less heavy and medium-powered tractors have proved adequate; and the area being developed is virtually unpopulated. This is important as one of the chief factors limiting expansion is a shortage of labour. For this reason the fortunes of this scheme will be closely bound up with those of the adjoining Shendam Settlement.

Mechanization and planned settlement are the keynotes of the *Niger Agricultural Project* at Mokwa[3]. This aims at the development of 65,000 acres of empty savanna country under a system of tenant mixed-farming, and is managed by an operating company in which the Nigerian Government and the Colonial Development Corporation hold equal shares. The project is spread over seven years and will establish ten villages, each consisting of eighty peasant holdings of forty-eight acres. Mechanized equipment is being used in clearing and will be available to the settlers; and the ultimate aim is to establish a large cultivated area, cropped on scientific lines, with each peasant retaining his village community life. Details of rotations have not yet been finally decided though a six-year, three-course rotation of cereals, oil-seeds and grass leys has been planned and livestock will be integrated into the system. Co-operation between settlers and management has been good and the scheme has been hailed as "from every point of view—political, social, agricultural and economic—one of the most interesting and satisfactory of the Corporation's projects".

In addition, small-scale experiments in mechanized cultivation on a co-operative basis and within the framework of an established village group are being undertaken at several points in the Western Region[4]. *The Eruwa Mechanized Farming Scheme* is typical of these. It comprises some 500 acres of open savanna woodland; soils are light and sandy, and to minimize erosion the land is being contour-cultivated, with an alternation of cropped and fallow strips. The work of clearing is not heavy (20 man-days per acre) and some 200 acres are being cultivated with tractor-drawn equipment. The main crops are the basic food-crops followed by a green-manure crop, while one-fifth of the area is being set aside for pineapples which should prove valuable in view of the local canning industry.

At Irele a group of 100 farmers belonging to two villages agreed to clear and stump 400 acres which, it was proposed, should be farmed with the aid of mechanical

1. *Second Annual Report of the Northern Regional Production Development Board*, 1950-1, pp. 5-8.
2. See p. 24 above.
3. See *Commonwealth Survey* (London, 1950) and *Colonial Development Corporation: Report and Accounts for 1951* (London, 1952).
4. See the *Third Annual Report of the Western Regional Production Development Board*, 1951-2, pp. 14-5.

equipment provided by the Production Development Board. The machinery was to be used for breaking the land and for the initial cultivation, after which the land was to be sub-divided into individual plots for tillage by hand. The early enthusiam shown by the villagers waned rapidly when the amount of labour involved in clearing became apparent, and in spite of a subsequent modification of the scheme, the results have been disappointing. The farmers have shown little desire to abandon their traditional methods. This is undoubtedly due in part to local environmental conditions. The clearing and stumping of the dense virgin bush demands on the average 100 man-days per acre, and it is understandably difficult for the native farmer to appreciate the purpose behind such an operation when he knows that he can prepare his farm by the native method for as little as twenty man-days per acre[1]. In addition, soils are very patchy and many are of marginal value. Under these conditions the traditional system of bush-fallowing, with its pattern of scattered holdings following selectively patches of relatively fertile soil, represents a more satisfactory adjustment to local conditions.

These two schemes illustrate clearly some of the problems of mechanization in the area of dense vegetation and close settlement typical of much of the South. They serve, too, to underline the environmental advantages enjoyed by parts of the North, and especially the Sudan zone, with its more open vegetation and more homogeneous soil conditions.

(3) *Schemes of Integrated Rural Development*

Possibly the most striking demonstration of the potentialities of planned development on a regional scale is the Tennessee Valley Scheme in the Eastern United States. Here a carefully integrated scheme of agricultural improvement, reafforestation, flood control and hydro-electric development revolutionized the economy of what was one of the most backward regions in the country and opened the way to a fuller life for the Valley's four and a half million people. The lessons of the T.V.A. are particularly relevant in many parts of Africa today where Governments are faced with similar problems of wasting soil and vegetation assets, unused power resources and rural poverty. It is however, a striking comment on the lack of imagination and the narrowness of outlook of the various colonial administrations that these lessons should have been so long ignored. Against this background, the recent announcement of a scheme of planned regional development for the upper basin of the Ogun River in Western Nigeria takes on a new significance; it not only represents an important step in the development of the Western Region, but is indicative also of a new and more constructive approach to the development of the savanna lands of Africa.

The Ogun River project "links together the possibilities of hydro-electric power and a land-usage scheme employing improved cropping and stock-keeping methods .... Should the possibilities prove to be up to expectations, a large part of the country within 60 miles of the dam site should be provided with electric power ...."[2]. In the meantime the investigation of the power potential of the Amaka Gorge is still in progress and the agricultural development of the 26,000 acres selected as a project area is proceeding. Experimental development will be along two lines: on the one hand, mechanized production of food crops; on the other, livestock production on the open-range system. If these prove successful it is proposed to weld the two into a balanced system of mixed farming. The area consists of open savanna woodland with light, sandy soils

1. Ibid. 2. Op. cit., pp. 11-3.

unsuited to continuous cropping, so that a system of fallowing will be essential. The land is, therefore, being cultivated in strips, each aligned along the contour and alternately under fallow and crop. The rotation tentatively adopted is maize, followed by three years of *mucuna*, and then by three years of fallow. A smaller area has been set aside for the experimental cultivation of specialized food and cash crops, and for testing alternative rotations.

The savanna grasslands of the area are superior in both quality and length of grazing season to the grasslands of the Sudan zone and would appear well suited to livestock ranching. The area is tsetse-infested but the indigenous, dwarf shorthorn is resistant to trypanosomiasis, and the major limiting factor to the expansion of livestock numbers in the past appears to have been rinderpest. New techniques of rinderpest immunization applicable to the dwarf shorthorn seem likely to overcome this menace, and the way will then be open for a vast expansion of the livestock industry in these savanna areas. The Ogun Estate has a significant role to play in the provision of foundation herds vital to this expansion, and in the establishment of mixed-farming techniques suited to local conditions. These developments, linked with the harnessing of the Ogun River for power, may well revolutionize the rural economy of what is today one of the backwaters of the Western Region.

(4) *Livestock Production Schemes*

As in temperate regions, livestock have a dual contribution to make to tropical agriculture; they play an important role in maintaining soil fertility, and they make an essential contribution to a tropical diet. Though closely related these two aspects may for convenience be discussed separately.

For many generations the agricultural economy of Western Europe has been based on mixed farming, involving a close integration of arable and livestock farming on individual holdings. Such an integration has not been achieved in Nigeria where virtually the entire cattle population is in the hands of one ethnic group, the Fulani, and where over wide areas arable farming is carried on entirely without cattle. It has long been recognized by agricultural experts that this cleavage constitutes a serious element of weakness in the country's agricultural system, and a recent official report goes so far as to declare, "There can be no solution to Northern Nigeria's agricultural problem so long as the cattle population remains divorced from its soil[1]". The advantages to be derived from a system of mixed farming are many: the replacement of human labour by that of draught animals; the raising of the soil nutrient status by farmyard manure, and the eventual replacement of the land-prodigal system of shifting cultivation by permanent rotational farming; the extension of the cultivated area and the diversification of cropping; and, finally, the expansion of the output of those livestock products which are essential to correct the protein deficiencies of typical Nigerian diets. Under a system of mixed farming a holding of, say, 12 acres, would support two draught animals which, properly kraaled, would supply enough manure to dress four acres each year. These four acres would then be planted to the main food crop (millet or guinea corn) and the remaining acreage devoted to cash crops. With a simple rotation the whole plot will receive a dressing of farmyard manure every three years. This is a simplified example; it will be obvious that the size of the holding and the balance between food crops (including fodder crops) and cash crops will show considerable regional variation.

1. *Report of the Nigerian Livestock Mission (Colonial No. 226)* (London, 1950).

The system was introduced into the Northern Province twenty-five years ago, but little progress has been made outside the central sector of the Sudan zone, and even here the number of mixed farmers represents an infinitesimal proportion of the total farming population[1]. The excessively small size of many holdings, the difficulties of obtaining both cattle and ploughs, and the absence of any tradition of livestock management among the settled Hausa population, have all been limiting factors of some importance.

Outside the Sudan zone mixed farming is virtually non-existent, for in both the Middle Belt and the southern forest heavy tsetse infestation at present limits its development. It has, nevertheless, been shown that farm-yard manure will maintain a high level of fertility under intensive cropping, even on the poor soils of Iboland, and it seems clear that the solution to the problem of maintaining soil fertility in these areas, no less than in the Sudan zone of the North, lies in a system of mixed farming. Under these conditions the development of trypanosomiasis-resistant livestock strains becomes a matter of vital concern to the well-being of some two-thirds of the Territory's population.

Quite apart from the importance of stock in the maintenance of soil fertility, the marked deficiency of the tropical diet in animal proteins has focussed attention upon the need for expanding livestock production as part of a general drive to raise the level of living of the tropical peoples. Thus the expansion of livestock numbers in Oyo Province is important not only from the point of view of soil fertility, but also from that of nutrition, since it will provide an important supply of animal protein within easy access of the urban markets of Yorubaland. In the Eastern Region the economics of livestock production to meet the needs of the great concentration of population in Iboland are being investigated on a pilot ranch at Obudu in Ogoja Province[2]. Here, on the flanks of the Cameroons highlands, wide expanses of high-level, tsetse-free grasslands have long been used by the nomadic Fulani, and here the Eastern Regional Production Development Board has established a 20,000-acre ranch, with the intention of running some 4,000 head of cattle, together with flocks of sheep and herds of pigs. The contribution of this pilot scheme to the meat supply of the East will not be large. It is, however, stressed that the carcase weight of the Obudu cattle will be twice that of the emaciated beasts trekked into the Region either from the North or from the French Cameroons; while the scheme, if successful, will provide a pattern for the large-scale development of commercial ranching in the Cameroons grasslands.

(5) *Plantation Development Schemes*[3]

The agricultural development of Nigeria during the past half-century has been based on peasant production and the role of plantation agriculture has been small. The results achieved with annual crops such as groundnuts, cotton and benniseed have been striking, but it is becoming increasingly doubtful whether, in a normal market, peasant production of perennial tree crops will be able to compete with the higher quality and more efficiently produced plantation product. This is particularly true of palm products, a commodity on which some four million Nigerian farmers are totally dependent, but which in the future may expect to face sharp competition from plantation-produced oil from the Congo and Indonesia. The policy of the Eastern and Western Regional Production Development Boards in initiating schemes of plantation development to increase

1. E.g., a thousand out of some 500,000 farmers in Kano Emirate.
2. See the *Second Annual Report of the Eastern Regional Production Development Board*, 1951-2, pp. 32-8.
3. See "The Future of the Nigerian Palm Oil Industry", *African Affairs*, Vol. 47 (London, 1948); "Plantations in Africa", *United Africa Company Statistical and Economic Review* (London, March, 1952); and "Palm Oil Production in Nigeria", ibid. (March, 1951).

the output of both cash crops and food crops, to introduce new cash crops and to improve the quality and quantity of palm products, indicates a growing, but dangerously belated, awareness of the limitations of peasant methods in the production of tropical perennials. These new plantation projects fall into three broad groups:—

(1) Schemes of large-scale plantation development, usually in thinly populated areas, operated either directly or through the agency of a commercial firm.

(2) Small-scale plantations, which can be dispersed in groups in all save the most closely settled areas, and which will make available to surrounding villages not only modern processing facilities but also high-grade seed, and which will ultimately be taken over by the local villages.

(3) Co-operative development, on plantation lines, of existing areas of perennial tree-crops.

In the Eastern Region two major plantation enterprises are to be developed on the edge of the Oban Forest Reserve in Calabar Province. The first of these, the *Calaro Oil-Palm Estate,* comprises an area of 12,500 acres and is being developed on the basis of a partnership between the Eastern Regional Production Development Board and the Colonial Development Corporation. The second, the *Oban Rubber Plantation,* will comprise a similar area and is to be developed jointly by the *Production Development Board* and a commercial rubber firm. The area in which these schemes are being established is thinly peopled and the plantations will provide regular employment for a considerable labour force drawn from the over-populated parts of Iboland. In the Western Region, the *Ijebu Farming Project* represents an interesting example of large-scale *mixed* plantation development. This project comprises an area of 13,000 acres and, like the Calabar scheme, is located in what was formerly a Forest Reserve[1]. It is to be developed as an estate for the cultivation of oil-palms, citrus, cocoa and rubber, and is intended to be taken over ultimately by African interests. In contrast to some of the schemes in the Northern Region, there is at present no intention of establishing settlers, and during the initial stages the plantation is being worked by paid labour recruited locally or in the Eastern and Northern Regions. Citrus production will be adequate to maintain a modern canning factory, and at the same time, the plantation will be able to supply improved plants to farmers wishing to extend their acreages. It will also provide a large-scale demonstration of efficient plantation management and of techniques evolved to suit local conditions.

The establishment in the Eastern Region of groups of smaller oil-palm plantations which might provide processing facilities and act as models for village plantation development has been hindered by the difficulty of obtaining land. In view of the urgent need to replace existing groves of over-age wild palms by improved plantings, this delay is particularly unfortunate. Other small-scale plantation schemes include the establishment of cashew plantations (the nut is the only natural source of phenol, as well as being used in the confectionery trade) on the eroded areas of the Udi district; a 1,000-acre pilot plantation of coconuts on the coast; and a 1,200-acre plantation of *Arabica* coffee in the Cameroons. This last will provide a model for local coffee-growers, who will also be able to utilize the services of the plantation's factory for the processing of their crops.

1. H. Spottiswoode, "The Ijebu Farming Project", *Nigerian Marketing and Regional Production Development Board's Journal,* Vol. 1, No. 2 (1952).

In addition to initiating development projects, the Production Development Boards are giving support to schemes of agricultural development on a community or co-operative basis at several points in the Western Region. This pattern of development combines the social advantages of peasant production with the technical advantages of the plantation system, and would appear to have a promising future in the perennial tree-crop regions of the South.

(6) *Irrigation Schemes*

An extension of the acreage under irrigation in the sub-humid areas of the Middle Belt and the Sudan zone would permit a considerable expansion in the production of specialized crops such as rice, cane and vegetables; and by permitting dry-season cropping, would help to even out the highly seasonal pattern of farming activities typical of most of the savanna region. Environmental conditions and the absence of basic topographical, climatological and hydrological data are, however, serious obstacles to any large-scale development in the immediate future, though a promising small-scale scheme is being initiated in Niger Province. This undertaking is situated in the valley of the Kaduna River and is a pilot scheme covering some 2,500 acres. "Approximately 1,500 acres of land on which rice cannot be cultivated at present will be made available for rice; sufficient water should be available for the dry-season irrigation of up to 1,000 acres". On the Gbako River, in the same area, recent investigations suggest that a scheme ten times this size may be possible. Outside this area interest has centred on the development of small-scale village schemes, though reconnaissance work has drawn attention to the possibilities of a major scheme in the Lake Chad area. This would involve dyking of the dry-season shore-line of the lake and the utilization of the pent-up water of the rainy season for the irrigation of an area which might run into hundreds of thousands of acres.

Finally, it is appropriate to include here the development of rice-growing in the coastal swamps of the Territory. Successful rice cultivation in the coastal belt of Sierra Leone and adjoining territories provided the initial impetus for experiments in Nigeria. Unfortunately preliminary investigations in the coastal swamps of Warri Province have shown that soil conditions are less favourable and yields much lower than in Sierra Leone, while soil loss by tidal scour is a major problem. In spite of these difficulties, however, a yield of 900 lb. of padi per acre has been obtained, and with growing population pressure and soil depletion in parts of the South, the coastal swamps may come to play an increasingly important role in the country's food economy.

Conclusion

African peasant farming, based upon the restorative bush fallow, represents an admirable adjustment to the poverty of the African environment, and for long sufficed to maintain population and food supply in delicate equilibrium. For reasons outlined in the introductory paragraph, this equilibrium is breaking down and the old system of farming is on the verge of collapse. The development projects discussed above are experiments designed to establish a new basis for African peasant farming. Or, perhaps more accurately, we should say 'new bases', for it is abundantly clear that there is no one, simple solution to these problems. Even in a single territory such as Nigeria, differing environmental conditions call for different solutions to the problems. Thus, in thinly peopled areas with open vegetation and relatively homogeneous soil conditions, large-scale mechanized cultivation on the Mokwa pattern may offer the greatest possibilities for a rapid expansion of crop output. In the more closely settled sectors of the

high-forest country the future seems to lie in a judicious development of co-operative farming systems with limited mechanization, as at Eruwa. In the thinly peopled high-forest country the best hope may lie in plantation development under partnership conditions, as in Calabar Province. Elsewhere, as in the Ogun valley or the valley of the Sokoto or Zamfara Rivers, there appears to be scope for large-scale schemes of integrated rural development on the lines of the T.V.A. Each environmental region presents problems peculiar to itself and calls for an individual solution. The problem of defining these regions on the basis of environmental conditions and adapted land-use practices then becomes one of the major tasks of agricultural geography in the Tropics.

The experiments in Nigeria have also served to emphasize that we are working in an environment whose potentialities and limitations we know only very inadequately. Basic data on climate, soils, vegetation and hydrographic conditions are still lacking. In certain areas, as we have shown above, patchy soil conditions favour the traditional 'scattered' holding and rule out large, compact (and hence highly mechanized) units. Yet, until we have detailed soil maps it is impossible to assess the importance of this factor of soil patchiness in agricultural development. Similarly, in the absence of basic hydrographic data, it is impossible to assess the potential importance of irrigation in the *fadamas* of the Sudan zone, for the limited use at present made of these seasonal swamps may well be a reflection of the extremely erratic water regime observed in some otherwise seemingly promising areas. A third major lacuna in our knowledge relates to the grasses of the Sudan and Guinea zones which are of vital importance in the Territory's grazing economy, but whose grazing potentialities and management have as yet not been systematically studied.

Equally important are the human difficulties. The attachment to the land of some of the southern peoples is a major obstacle to planned internal colonization. Even if this were overcome, the deep-seated antagonism of the Christian or pagan peoples of the south to the Mohammedan peoples of the north would be a major obstacle to any transfer of population between the over-populated Ibo country and the thinly peopled areas of the Middle Belt or Bornu. The development of livestock production and the extension of mixed farming is hampered by the fact that, except among the Fulani, there is no tradition of stock-rearing and management among any of Nigeria's peoples. In the South peasant conservatism has stood in the way of those rapid and effective counter-measures which alone can arrest the spread of swollen shoot disease in the Cocoa Belt, and has proved a major obstacle to the introduction of more effective mechanical methods of palm-oil extraction. There can be no solution to these difficulties without a vast improvement in the level of rural education. To base ambitious schemes of economic development upon a largely illiterate and suspicious peasantry is to court disaster.

Finally, recent development work has emphasized the need for an integrated approach to the problem of rural development. The dietician may insist that the peoples of the North need more fruit; the agricultural officer may succeed in establishing the trees in the areas most suited to them, that is, in the river valleys; yet the sleeping sickness officer points out that groves of fruit trees along the streams of the Sudan zone constitute, in effect, artificial *galeria* forests and act as important corridors of tsetse advance into fly-free areas. The forester may point out the vital need to safeguard the Territory's fuel and timber supplies, yet the veterinary officer and the doctor find that the forest reserves constitute potential reservoirs of game and tsetse flies menacing the health of adjoining human and animal populations. The development of swamp-rice production is undoubtedly one answer to the problem of feeding the peoples of Africa, and some of the *fadamas* of the Sudan zone appear well suited to such development. These

seasonal swamps, however, play a vital role in the grazing economy of the Fulani, and their cultivation will necessitate major alterations in the long-established and delicately adjusted way of life of these pastoral groups. A carefully integrated and cautious approach to all development problems, with the closest collaboration between the medical man, the forester, the agriculturalist and the administrator, is essential for sound rural progress.

One general point may be emphasized in conclusion. It is still fashionable to regard the African tropics as potential reservoirs of foodstuffs for the temperate world. It cannot be too strongly stressed that such a view is rooted in ignorance of African conditions and has little basis in reality. Malnutrition is an essential feature of the sociology of the African tropics. Under a more positive policy of promoting African welfare (which will inevitably follow the Africanization of government in the British tropical African territories) the African consumer can be expected to absorb a growing proportion of the so called 'export surpluses' of these territories. Further, the peoples of British Africa appear to be entering a period of rapid population growth which will absorb much of the output of an improved peasant agriculture. It is a striking comment on the Europocentric character of many recent development projects that this aspect should have been so largely overlooked. With the possible dwindling of these territories' exports of oil-seeds and other foodstuffs one may look forward to a growing demand for local industrialization (based in Nigeria on local low-grade coal, water-power, ores and agricultural and forestry products), and to a striking readjustment in the economic relations between the metropolitain power and its colonial dependencies. Practically, this means that future increases in world food output must be sought, not in the so-called undeveloped areas of the Tropics but in those mid-latitude regions such as the Mississippi and Parana basins, and in New Zealand, where climatic and soil conditions are far more favourable than in the Tropics.

TAKOLA EMPORION

A Study of an Early Malayan Place-Name

By PAUL WHEATLEY

THE FOUNDATION of the study of historical geography is the accurate identification of place-names, but in Malaya of the pre-European period this is a proceeding fraught with even more than the usual difficulties. Source material is by no means abundant, and that which does exist is frequently confused and obscure. In the first place, in the Malay Peninsula the infant study of archæology is beset with many handicaps, not the least of which is a dearth of workers. Then to the ravages of climate, insects and moulds must be added the erosive power of tropical rainfall, the obliteration of evidence by the deposition of alluvium, and the difficulty of prospecting for sites most of which lie hidden beneath a mantle of tropical vegetation. Second, literary and epigraphic references may be in any one of the Chinese, Indian, Arab, Indonesian or European languages, and are often in more than one, which introduces the problem of translation and transliteration from one language to another. Then the evidence of these different sources is often contradictory, a problem rendered yet more complicated by the frequency with which place-names are duplicated. Over the past century some progress has been made in resolving these complexities, but a large number of place-names still cannot be identified with certainty. In the following notes I shall assemble the evidence bearing on the site of *Takola*, one of the most important of these early names.

PTOLEMAIC EVIDENCE

The earliest extant description of South-East Asia[1] is contained in the *Geographike Huphegesis*, compiled in the middle of the second century A.D. by the Alexandrine, Claudius Ptolemy; and in Chapter 2 of Book VII we find him beginning his account of the Malay Peninsula[2].

(In) the Golden Chersonese:—

Takola, an emporium	160° 30′E; 4° 15′N.
The promontory situated beyond this town ..	158° 20′E; 2° 20′N.

At first glance it seems that the Ptolemaic latitude and longitude define the site of *Takola* with precision, but on closer examination we find that this is an illusion. In the ancient world the only methods of obtaining latitudes were to measure the altitude of *Polaris* or the duration of the longest day, but the instruments available for both these observations were of very limited accuracy[3]. Even within the frontiers of the Roman Empire such observations were few, and beyond the *limes* they could hardly have existed at all. A Ptolemaic longitude was even less reliable. In theory it represented the difference in time

1. Earlier writers had occasionally mentioned a *Golden Land* beyond the Ganges, but none had located it accurately or described it. E.g., Pomponius Mela had made passing reference in about A.D. 43 to *Chryse* [*De Chorographia*, most easily accessible in G. Coedès, *Textes d'Auteurs Grecs et Latins Relatifs a l'Extrême-Orient* (Paris, 1910), p. 12]: and Pliny, in about A.D. 77, knew of a promontory of that name (Coedès, op. cit., p. 15), which is also mentioned in the *Periplus Maris Erythræi*, compiled about the close of the first century, A.D.—See W. H. Schoff's edition (Philadelphia, 1912), pp. 46 and 47-8.

2. The definitive text for Book VII is that established by L. Renou, *La Géographie de Ptolémée, l'Inde (VII, 1-4)* (Paris, 1925). The account of the Malay Peninsula begins on p. 45.

3. See, for example, Strabo's remarks on latitudes in H. L. Jones, *The Geography of Strabo*, Vol. 1 (London, 1917), pp. 331-3.

between the place in question and the prime meridian passing through the Fortunate Isles[1], but until chronometers were invented, such a calculation could be little more than an informed guess[2].

How then does it happen that Ptolemy recorded both latitudes and longitudes to within five minutes? The answer lies in Ptolemy's intention. He was not primarily a geographer studying the countries of the world; rather was he a practical astronomer seeking to extend and refine his observations. As these varied according to the position of the observer on the surface of the earth, Ptolemy undertook to construct a more accurate map of the world than had hitherto existed. In the absence of adequate observational data, when fixing positions he had to rely on the authority of earlier writers, and on times and distances recorded by travellers[3]. Within the confines of the Roman Empire overland distances were known fairly accurately, but the vagaries of wind and weather, and the lack of compass and log, rendered marine itineraries, particularly those outside the trade-wind belt, prodigious sources of error[4]. It was with such voyages that Ptolemy was concerned in Book VII, for his main positions in South-East Asia were coastal, and his informants seem to have been almost exclusively seamen[5]. The sailing times and distances which they recorded must have been extremely variable, especially after they had passed Achin Head, but Ptolemy reduced them all to an average of 516 *stadia* a day[6]. Having constructed his world map from such data, Ptolemy then read off and recorded the supposed latitudes and longitudes of some 8,000 selected places for the benefit of his fellow astronomers. Thus, his lists of latitudes, far from constituting the data from which his map was constructed, partake rather of the nature of an index to it[7].

Three other aspects of Ptolemy's calculations must also be mentioned. First, he adopted the erroneous computation of Posidonius (c. 135–150 B.C.) that the circumference of the earth was 180,000 *stadia,* from which he deduced that one degree of latitude or longitude at the equator was equal to 500 *stadia.* In fact, it was equal to 600 *stadia,* and this error accumulated progressively eastwards from the prime meridian until it reached its maximum in eastern Asia. Second, owing to the fact that Ptolemy had no real knowledge of the Fortunate Isles, he misplaced his prime meridian to such an extent that all his longitudes reckoned eastwards were about seven degrees less than true. Third,

1. Madeira and the Canary Islands.

2. Even in the sixteenth century A.D. Richard Eden could write, "Some doo understand that the knowledge of the Longitude myght be founde, a thynge doubtlesse greatly to be desyred, and hytherto not certaynly knowen . . . . . ." ——"Epistle Dedicatory" to Eden's translation of John Taisnier's *A Very Necessarie and Profitable Book Concerning Navigation* (London, 1579?).

3. Ptolemy sets out his method in Paragraph 2 of Chapter 4 of Book 1:

> " . . . . . if visitors to different countries had made the necessary observations, we should have been able to construct a definitive map of the world; but only Hipparchus has recorded for us altitudes of the North Polar Star and noted which places are situated in similar latitudes (and then only for a few of the immense number of positions needed to construct a map of the world); while a few later writers have noted that certain places are situated on the same meridian . . . . . but distances between points, especially from east to west, have been calculated only approximately . . . . . so that the proper method of constructing a world map would be first to plot those positions fixed by accurate observation, and then to manipulate the data for positions obtained from other sources so as to fit them into this framework with the least possible distortion".

I have tried to render this turgid and involved passage into easily intelligible English. A literal translation may be conveniently consulted in E. H. Bunbury, *A History of Ancient Geography,* Vol. 2 (London, 1879), pp. 554-5.

4. There are no reliable data for times of travel in the Indian Ocean at this period, but E. H. Warmington, using material from the *Corpus Inscriptionum Græcarum,* 4957, *"Agyptische Urkunden aus den Kön. Museen z. Berlin. Griechische Urkunden 646 (Pertinax)* and U. Wilcken, *Griechische Ostraka,* has shown that even the voyage between such familiar points as Puteoli and Alexandria varied greatly according to the season of the year and conditions of war. Apparently news could reach Egypt in as short a time as twenty-seven days in summer, or as long as sixty-seven days in winter. In spring it might take at least fifty-two days to reach the Fayum; in summer perhaps only fifty-seven to travel all the way to Elephantine.—*The Commerce Between the Roman Empire and India* (Cambridge, 1928), p. 50. Warmington (ibid.) has also estimated that the average duration of a journey from Italy to India was about six months.

5. In Chapter 17 of Book I Ptolemy tells us that Marinos of Tyre, from whom he obtained much of his material, had relied on the reports of sailors who had dwelt in India.

6. The Olympic *stadium* is equivalent to 600 Greek, or 606¾ English, feet. Thus 10 *stadia* are approximately equal to one nautical mile.

7. For more detailed expositions of this point of view see Bunbury, op. cit., pp. 554-76, and J. O. Thomson, *A History of Ancient Geography* (Cambridge, 1948), pp. 336-43.

Ptolemy had no astronomical observations from the region of the Equator, so that he was forced to calculate its position relative to the northern tropic. Unfortunately, as Ptolemy's degree was only five-sixths of a true degree, he placed his Equator some 230 nautical miles too far to the north.

These last three errors, it is true, are constant, and this has led some investigators, notably Gerini[1], Rylands[2] and Berthelot[3], to seek for mathematical formulæ which would convert Ptolemaic positions to true latitudes and longitudes. As far as errors of scale and graticule are concerned these scholars have been more or less successful, but they have failed to take full account of the extent to which Ptolemy's superstructure of latitudes and longitudes is based, not on astronomical observation, but on distances culled from itineraries. For such materials there is, and can be, no formula of universal application. I have entered into this subject at some length because I wish clearly to refute the notion that Ptolemy's co-ordinates can be guides to the identification of place-names in South-East Asia. In the Mediterranean world they may serve this purpose[4], but beyond the Parthian frontier who can suppose that astronomical observations were other than very rare? In fact, had they existed at all Ptolemy could hardly have failed to detect his rapidly increasing errors of scale[5].

What, then, does Ptolemy tell us about *Takola?* His co-ordinates, we have seen, are valueless, and he scorns descriptive matter. But if we re-draw his map of the Golden Chersonese from the data contained in his tables[6], the general agreement between it and an outline of the Malay Peninsula is too complete to be explained by coincidence alone. There can be no doubt that Ptolemy's map was compiled from authentic information. Clearly he intended his readers to conceive of *Takola* as a trading centre[7] on the west coast of the Malay Peninsula, and at the head of a bay or estuary between two promontories[8]. These promontories have been variously interpreted, but there has been a strong tendency among authors to identify the more northerly one with Puket Island, and this has induced Sir Roland Braddell, for example, to insist that *Takola* must have been situated to the south of that point, in the neighbourhood of Trang[9]. It seems unlikely that Ptolemy, who was almost wholly ignorant of the peninsular character of southern India[10], and who inflated Ceylon to something like fourteen times its true size[11], had such a precise conception of either the number of promontories on the west coast of Malaya, or of their shape. It is more probable that the two headlands which he mapped were merely the two which figured in the accounts of his informants as features on the approaches to *Takola*. This is the sum of the knowledge which can be gleaned from

1. G. E. Gerini, *Researches on Ptolemy's Geography of Eastern Asia* (London, 1909), pp. 9-25.

2. T. G. Rylands, *The Geography of Ptolemy Elucidated* (Dublin, 1893), pp. 36-80.

3. A. Berthelot, *L'Asie Ancienne Centrale et Sud-Orientale d'Après Ptolémée* (Paris, 1930), pp. 120-45.

4. But, had Ptolemy's co-ordinates played any real part in the construction of his maps, he would hardly have recorded the island of Elba twice, once under a Latin, and once under a Greek name (Bk. III, Chap. 1, para. 78).

5. Ptolemy himself recognized the limitations of his map, and para. 4 of Chap. 2, Bk. I is his apologia. But he avoided the error, made by so many latter-day commentators, of seeking a comprehensive correction factor. He fully realized that such a formula would have to take account of the meanderings of roads and rivers, of inequalities of surface, the physique of the traveller and of his pack animals, and of irregularities of wind force and direction, as well as of the frequency with which the route was used.

6. It is disputable how far the maps accompanying the several MSS. represent Ptolemy's original series, but a new set can be drawn at any time from the data in Bk. VII. A fourteenth century reconstruction of the Golden Chersonese, from the MS. *Venetus 516* (R), is conveniently reproduced at the end of Renou, *op. cit.*

7. Ptolemy did not use the epithet *emporion* indiscriminately. Warmington, op. cit., p. 107, gives reasons for believing it denoted "an authorised sea-coast (not inland) mart in the Orient where *non*-Roman dues were levied by *non*-Roman authorities".

8. See Renou, op. cit., p. 45.

9. Dato Sir Roland Braddell, "An Introduction to the Study of Ancient Times in the Malay Peninsula and the Straits of Malacca", *Journal of the Malayan Branch of the Royal Asiatic Society*, Vol. 14, pt. 3 (Singapore, 1936), pp. 26, 34-5; Vol. 17, pt. 1 (1939), p. 204; and "Notes on Ancient Times in Malaya", *J.M.B.R.A.S.*, Vol. 22, pt. 1 (1949), p. 2.

10. See, for example, the *Carte de l'Inde Cisgangétique* at the end of Renou, op. cit.

11. See, for example, the Carte de Taprobane, ibid.

Ptolemy's data, and subsequent European writers either copied from him or were ignorant of the existence of the Golden Chersonese[1]. For supplementary information we must turn to contemporary accounts in Indian, Chinese and Arab writings.

Indian Evidence

The peoples of Peninsular India, in view of their commercial and proselytizing activities in South-East Asia during the early years of this era, might be expected to have bequeathed us a corpus of evidence of some magnitude. On the contrary, there are but few references to Malaya in Indian literature, and such as do exist are, generally speaking, vague and ambiguous. Professor Sylvain Lévi drew attention to one such reference in 1925[2]. This occurs as a gloss on a word in the *Maha Niddesa*, a part of the Pali Buddhist canon from the second or third century, A.D., and reads as follows:—

> .... he puts forth on to the high seas, and enduring frost and heat, mosquitoes and stinging insects, wind and sun, and hunger and thirst, he voyages on to Gumba, Takkola, Takkasila, Kalamukha ....[3].

This same list of places is repeated word for word in another gloss in the same work[4]. Clearly it was a stereotyped sample of local colour introduced by the editor of the *Maha Niddesa* whenever the occasion presented itself. The order in which these places are mentioned shows that the list cannot be regarded as a coherent itinerary, and Sir Roland Braddell is quite right to reject it as being "of no real assistance in identifying any single place geographically"[5]. What the list does show, however, is that *Takkola* was a port well-known by name to Indians of the period. But this, and the fact that it was ranked in the list with, say, Alexandria, should not be adduced as a measure of its importance in the ancient world, for the context of the passage would seem to imply that, to the author of the *Maha Niddesa, Takkola* was little more than another exotic name for his catalogue.

A third reference carries us a little further. In the *Milindapañha,* probably compiled at approximately the same time as the *Maha Niddesa*[6], we read:—

> As a wealthy ship-owner scrupulously discharges his port dues and, putting forth on to the high seas, voyages to Vanga, to Takkola, Cina, Sovira, Suratha, Alasanda, Kolapattana, Suvannabhumi....[7].

This passage would seem to imply that *Takkola* could be regarded as an attractive destination for a merchant adventurer; and although the sequence of names cannot be combined into a trade-route, yet it may not be without significance that *Takkola* is placed between *Vanga* and *Cina. Cina* was, of course, China, and if, as Lévi thought, *Vanga* was Bengal[8], then *Takkola* would seem to have been situated somewhere between these two points, that is, on the coast of the Indo-Chinese Peninsula. But if Majumdar[9] is correct in identifying Vanga with the island of Bangka, the passage implies that *Takkola* was somewhere on the east coast of the Peninsula. This would be incompatible with Ptolemy's data, but, in view of later Arab evidence[10], is not to be excluded from our consideration.

1. These later sources have been collected and edited by Coedès, op. cit.
2. S. Lévi, "Ptolémée, le Niddesa et la Brhatkatha", *Etudes Asiatiques,* Vol. 2 (Paris, 1925), pp. 1-55.
3. From the French translation of Sylvain Lévi, ibid., pp. 1-2. Lévi prints a romanized transcription of this and the following passage, pp. 52-3. Thirty-four places are mentioned in the complete list.
4. Ibid.
5. Braddell, "Ancient Times", Vol. 14, pt. 1 (1939), p. 158.
6. See Lévi, op. cit., p. 51, but K. A. Nilakanta Sastri, *The Colas,* Vol. I (Madras, 1935), p. 623, dates it as c. A.D. 400.
7. I am indebted to Professor K. A. Nilakanta Sastri for the interpretation of this passage.
8. Lévi, op. cit., p. 3, but see also pp. 27-8 for an alternative reading.
9. R. C. Majumdar, *Suvarnadvipa,* Part I (Dacca, 1937), pp. 57-8.
10. See p. 42 below.

The next piece of evidence is of a somewhat different nature. As long ago as 1902, Mr. Kanakasabhai[1] suggested that the *Takola* of Ptolemy might be the *Talaittakkolam* of the Tanjore Inscription of A.D. 1030–1:—

> And he (Rajendra Cola I), having despatched many ships into the midst of the rolling sea .... (captured) .... Sri-Vijaya .... Malaiyur .... Ilangasogam .... Talaittakkolam, praised by great men of science; Madamalingam .... Ilamuridesam .... Manakkavaram .... Kadaram[2].

The identity of *Takola* and *Talaittakkolam*[3] has been accepted by nearly all later writers[4], and notably by Coedès[5] who also identifies *Sri-Vijaya* with Palembang; *Malaiyur* with Jambi; *Ilangasogam* with *Langkasuka; Madamalingam* with *Tambralinga,* just south of the Kra Isthmus; *Ilamuridesam* with part of North Sumatra[6]; *Manakkavaram* with the Nicobar Islands, and *Kadaram* with Kedah. As the other places mentioned in this inscription were all on the Indo-Chinese Peninsula, in Sumatra, or on neighbouring islands, it is not unlikely that *Takkola,* too, was situated in this area. Thus, the Indian evidence as a whole, although it does not locate *Takkola* or *Takola* precisely or conclusively, does afford additional indications that such a place was in existence on or near the Malay Peninsula between the third and eleventh centuries of this era.

Chinese Evidence[7]

The Chinese evidence bearing on the problem of *Takola* is the most extensive of that in any language, but it also requires the most careful handling. To the difficulties of working with an ideographic script must be added the obscurity and ambiguity of many of the texts and the lack of agreement among commentators. Further, it is more than probable that there are other references among the numerous texts as yet unpublished.

In 1896 Sylvain Lévi[8] drew attention to a passage in the *Liang Shu*[9] of the seventh century A.D., relating the travels of an envoy from Funan to India during the period of the Wu dynasty (A.D. 222–80).

> He departed from Funan at the port of *T'ou-chü-li* (投 拘 利) and coasted along a great gulf of the sea. Directly to the north-west he came upon, and passed by, a number of kingdoms on the edge of a bay. More than a year later he entered the estuary of the *River of India.*

This route is also found in a text compiled at the beginning of the previous century, the *Shui Ching Chu*[10]:—

> After leaving the port of *Chü-li* (拘 利) and entering a great gulf, the route runs directly north-westwards, and leads, after a journey of just over a year, to the *River of T'ien-chu* (India).

1. M. Kanakasabhai, "The Conquest of Bengal and Burma by the Tamils", *Madras Review* (Madras, 1902), p. 251.
2. After the translation in Majumdar, op. cit., pp. 173-4.
3. The prefix *talai* is the Tamil word for *head* or *chief*. The accompanying phrase has no descriptive value: it is merely a play upon words, e.g. Tamil *Kalai* means *science* and *takkor* means *scholar*. Therefore, *Talaittakkolam* is designated as *praised by great men of science.*
4. Notably by V. A. Smith, *Early History of India* (Oxford, 1914), p. 466; G. Ferrand, *Relations de Voyages et Textes Géographiques Arabes, Persans et Turks Relatifs à l'Extrême-Orient*, Vol. 2 (Paris, 1914), p. 647, footnote 5, and *L'Empire Sumatranais de Crivijaya* (Paris, 1922), p. 45; Majumdar, op. cit., p. 177; and Sastri, op. cit., p. 262.
5. G. Coedès, "Le Royaume de Crivijaya", *Bulletin de l'Ecole Francaise d'Extrême-Orient*, Vol. 18 (Hanoi, 1918), p. 15, and *Les Etats Hindouisés d'Indochine et d'Indonésie* (Paris, 1948), pp. 240-2.
6. The *Lamuri* of Arab geographers, and *Lambri* of Marco Polo.
7. I wish to thank Mr. M. Blackmore for valuable help with this section.
8. S. Lévi, "Deux Peuples Méconnus", *Mélanges Charles de Harlez* (Leiden, 1896), p. 176.
9. Ch. 54, f. 10 recto. References in this section are from the *Ssu Pu Pei Yao* edition.
10. Ch. 1, f. 12 verso. This passage is, in fact, a quotation from the *Fu nan t'u su ch'uan of K'ang T'ai.*

So closely do these two itineraries coincide that there can be little doubt that the point of departure is the same in each, namely投拘利 or 拘利, Pelliot[1] and Luce[2] have identified the *River of India* with the Ganges, so that it would seem that we must seek the port of *T'ou-chü-li* somewhere on the west coast of the Indo-Chinese Peninsula. In fact, Lévi, Pelliot and Coedès have all suggested that it was the Ptolemaic *Takola*[3].

Now this place-name, in the form *Chü-li,* probably occurs again in the *T'ai p'ing huan yü chi*[4], compiled at the end of the tenth century A.D. The substance of its information is that, after leaving *Funan* and crossing the great gulf of *Chin-lin,* a voyage of 3,000 *li* southwards leads to four kingdoms, one of which is *Chü-li* (拘利)[5]. *Funan* was the region of the Mekong delta[6] and the Bay of *Chin-lin* has been variously identified as the Gulf of Siam[7] or the Gulf of Martaban[8]. Whichever may be correct, *Chü-li* or *T'ou-chü-li* would seem to have been on the Malay Peninsula or a neighbouring island[9].

Another piece of evidence is possibly to be found in *Chia Tan's* itinerary in the *Hsin T'ang Shu*[10]:—

> Five days' journey brings one to a strait extending 100 li from south to north and called Chih by the barbarians[11]. On the northern shore is the kingdom of Lo-Yüeh (羅越)[12]; on the southern shore is the kingdom of Fo-shih (佛逝)[13]; four or five days' sailing east of Fo-shih is the kingdom of Ho-ling[14] (訶陵), the largest of the southern islands ..... On the northern shore there is the kingdom of Ko-lo (箇羅), and west of this is the kingdom of Ko-Ku-lo (哥谷羅) ....

Groeneveldt[15], Pelliot[16] and Ferrand[17] identify *Ko-lo* with the *Kalah* of the Arab geographers and hence with modern Kedah, so that presumably *Ko-Ku-lo* was situated on the Malay Peninsula somewhere north-west of Kedah. If this is so, it is difficult to dissociate it from the *Takola* of Ptolemy, or the *Takkola* of the Sanskrit texts.

Elsewhere in the *Hsin T'ang Shu, Ko-Ku-lo* is mentioned again[18]:—

> Lo-yüeh is 5,000 li northwards from the sea. To the south-west is *Ko-Ku-lo* (哥谷羅).

In the present state of our knowledge the geography of this passage is inexplicable. Pelliot escapes from the impasse by supposing "that the text is not scrupulously accurate"[19], but this is an unsatisfactory solution. Probably the most that we can say is that *Ko-Ku-lo* is here mentioned as being in the neighbourhood of Malaya.

1. P. Pelliot, "*Deux Itinéraires de Chine en Inde à la Fin du VIIIe Siècle*", *B.E.F.E.O.*, Vol. 4 (1904), p. 386.
2. G. H. Luce, "Countries Neighbouring Burma", *Journal of the Burma Research Society*, Vol. 14, pt. 2 (Rangoon, 1925), p. 147.
3. Lévi, *op. cit.*, p. 4; Pelliot, "Le Fu-nan", *B.E.F.E.O.*, Vol. 3 (1903), p. 80; Coedès, *Les Etats Hindouisés*, pp. 73, 75.
4. Chap. 177, f. 7.
5. The others are *Pien-tou, Tu-k'un* and *Pi-sung*.
6. See, for example, Coedès, *Les Etats Hindouisés*, Carte Générale (at end of volume), and L. P. Briggs, *The Ancient Khmer Empire* (Philadelphia, 1951), p. 13.
7. Le Marquis d'Hervey de Saint-Denys, *Ethnographie des Peuples Etrangers à la Chine* (Geneva, 1883), p. 511, footnote 9.
8. Luce, op. cit., pp. 153-4.
9. The distance of 3,000 *li* is of no assistance in defining a more precise locality for the Chinese *li* has been a very variable measure.
10. Chap. 43C, f. 18 verso.
11. Identified by Luce as the Straits of Malacca, op. cit., p. 185, footnote 3
12. The southern part of the Malay Peninsula. See Pelliot, *B.E.F.E.O.* (1904), pp. 231-9; and G. Maspero, "La Géographie Politique de l'Indochine aux Environs de A.D. 960", *Etudes Asiatiques*, Vol. 2, map opp. p. 80.
13. Probably Palembang. See Pelliot, op. cit., pp. 384-54.
14. Java. See Pelliot, ibid.
15. W. P. Groeneveldt, "Notes on the Malay Archipelago and Malacca", *Miscellaneous Papers Relating to Indo-China and the Indian Archipelago*, Series 2 (London, 1887), p. 241.
16. Pelliot, ibid.
17. G. Ferrand, "Le K'ouen-Louen et les Anciennes Navigations", *Journal Asiatique*, Vol. 13 (Paris, 1919), p. 312, and "Malaka, Le Malayu et Malayur", *J.A.*, Vols. 11 and 12 (1918), p. 157.
18. Chap. 222C, f. 5 recto.
19. Pelliot, op. cit., p. 353.

This name appears yet again, in the *Sung Shih*[1], which tells of a Chinese monk who, in A.D. 983 was given imperial letters of introduction to the rulers of *San-fo-ts'i*, *Ko-ku-lo* (葛古羅) and *Ko-lan*. *San-fo-ts'i* was *Palembang*, *Ko-lan* was Quilon on the coast of Travancore, and it looks very much as if *Ko-Ku-lo* was an intermediate stage, perhaps, as Sylvain Lévi suggests, the point of departure for ships setting out to cross the Indian Ocean[2]. Even though we accept these identifications, the references are too vague to afford more than a very general idea of the locality in which *T'ou-chü-li* or *Ko-Ku-lo* was situated; but it does seem likely that we should search for it towards the north of the Malay Peninsula, and, if either or both of these names is to be identified with *Takola*, this does not conflict with Ptolemy's evidence.

Arab Evidence[3]

The Arab evidence refers to a later period than do most of the Indian and Chinese accounts we have examined so far, and is a product of the flowering of Islamic geographical studies between the ninth and fourteenth centuries.

In a paper in 1918, Gabriel Ferrand[4] identified the *Ko-Ku-lo* discussed above with the *Kakula* mentioned in an Arab text, the *Kitab 'adjaïb al-Hind* by Bozorg bin Sahriyar de Ramhormuz. This relates the story of a trading venture to *Kakula* in A.D. 922[5]. The merchandise was landed, and some of it transported to a country about seven days' march from the coast. Then, to escape the consequences of a misdemeanour, one of the crew fled from *Kakula* in a small sailing boat. The story continues as follows[6]:—

> .... je m'embarquai et pris la mer à tous risques, abandonnant la navire a sa solitude. Une navigation pénible de vingt et quelques *zam*[7] .... m'amena sur la côte d'une des îles Andaman .... Embarqué de nouveau, je naviguai sans direction, sans savoir où j'allais, pendant soixante-dix *zam* environ, et je tombai sur une île nommée Badfarkalah[8] .... De là je pus gagner Kalah[9].

Here then is a port named *Kakula*, situated in the vicinity of the Andaman Islands. It was the terminus of a maritime trade-route and, as part of the cargo was despatched into the hinterland, would seem to have been the starting point for overland communications.

Kakula is mentioned in at least five other Arabic texts, but Ferrand denies that any of them refer to the place under discussion[10], and prefers to place them in Eastern Indo-China. For four of these references this may be true[11], but it is debatable as far as the fifth is concerned. Kazwini (c. 1250) for example, speaks of

> .... the Mount of Djadur in the land of Kakula in Zabag. A kind of white falcon with red head feathers is found there, together with white monkeys bearded like rams, and another kind of monkey with a white belly and a black back[12].

1. Ch. 490. f. 2 recto.
2. Lévi, op. cit., p. 11.
3. I wish to thank Mr. G. R. Tibbetts and the Deputy Librarian of the *School of Oriental and African Studies* for help with this topic.
4. G. Ferrand, *Relations de Voyages et Textes Géographiques*, p. 157.
5. The MS. mentions the date 390 A.H. This is impossible, and Van der Lith has amended the text to read 309 A.H., i.e. A.D. 922. (See G. Ferrand, op. cit.), Vol. 2, p. 565.
6. From the French translation of M. Devic, under the title *Livre des Merveilles de l'Inde*, and with an annotated Arabic text by P. A. Van der Lith (Leyden, 1883-6), pp. 67-9.
7. About 70 hours (1 zam = 3 hours), but because of the character of the text no reliance can be placed on this figure.
8. Unidentified.
9. Kedah.
10. Ferrand, *J.A.*, Vol. 14 (1919), p. 43, footnote 1.
11. For these texts see Al-Edrisi (1154), Ibn Sa'id (c. 1250), Ibn Batuta (1355), and Ibn Iyas (1516), in Ferrand, *Textes Relatifs à l'Extrême-Orient*, pp. 199, 349, 426-58 and 481.
12. *Al-Kazwini, Kitab 'odjaib al-Makhlukat wa Gharaib al-Mawdjudat*. From the French of Ferrand, op. cit., p. 308.

Zabag was the Arab term for the *Sailendra* Kingdom of the Maharaja[1]. Now, we know that there were two focal points in the political structure of this empire, one in Sumatra, the other in the northern part of the Malay Peninsula, and it is not unlikely that *Kakula* constituted one unit in this thalassocracy. If we follow Ferrand, however, it becomes a matter of great difficulty to extend the dominions of the Maharaja to include places as far off as eastern Indo-China[2].

Thus, the Arab evidence confirms that from Indian and Chinese texts and gives some indications that *Kakula*, which may possibly have been *Takola*, was situated on the west coast, towards the north of the Malay Peninsula.

Etymological Evidence

In the present state of our knowledge of Asiatic languages, this tends to be the least satisfactory of the available bodies of evidence. Lévi and St. John have examined the etymology of *Takola* at some length[3]. Lévi points out that it is a Sanskrit word which occurs also in Pali literature and even in modern Indian languages such as Tamil and Telugu. Translators and commentators have ascribed various meanings to it, but all of them convey the idea of some aromatic plant such as bdellium, sandal-wood, camphor or cardamom. In Sanskrit and Pali texts the *t* is often replaced by a *k*, which reminds us that (1) the Arab word for cardamom is *Kakuli*, and (2) the Chinese histories place *Ko-Ku-lo* (哥 谷 羅) somewhere in the Malayan region[4]. Pelliot points out that the *ku* (谷) of *Ko-Ku-lo* derives from a former *kuk*, but that there is no trace of such a final gutteral in the Arabic *Kakula*[5]. This is a weighty objection to any theory identifying *Ko-Ku-lo* with *Kakula*, but in the *Sung Shih* the form of the name is 葛 古 羅[6], and in this 古 there is no trace of a final plosive.

The association of the *takkola-kakkola* of the Sanskrit and Pali texts with cardamom recalls the passage in the *Yu-Yang-tsa-tsu*[7] where we read that white cardamom (白 荳 蔻) comes from the land of *Chia-Ku-lo* (伽 古 羅), where it is called *to-ku* (多 骨). The ancient pronounciation of 多 骨 was *ta-kut*, from a possible *takur*, and Pelliot has suggested that there may be a connection between this early root, the *Takola* of Ptolemy, and the *Takkola* of the *Niddesa* and the *Milindapañha*[8].

Archæological Evidence

It is clear that the sum of the evidence discussed in these pages points to a position on the west coast, and towards the north, of the Malay Peninsula[9] as the site of *Takola*. Some of the identifications proposed here may have to be revised in the light of future research, but this need not invalidate our general conclusion. Yet the suggested locality is

1. See, for example, G. Coedès, "Le Royaume de Crivijaya", *B.E.F.E.O.*, Vol. 18 (1918), pp. 1-36; "A Propos d'une Nouvelle Théorie sur le site de S'rivijaya", *J.M.B.R.A.S.*, Vol. 14, pt. 3 (1936), pp. 1-9; and *Les Etats Hindouisés*, p. 185; but for other identifications see R. C. Majumdar, "Les Rois S'ailendra de Suvarnadvipa", *B.E.F.E.O.*, Vol. 33 (1933), p. 121; and "The S'ailendra Empire (up to the end of the tenth century A.D.), *Journal of the Greater India Society*, Vol. 1 (Calcutta, 1934), pp. 11-27; H. G. Q. Wales, "A Newly Explored Route of Ancient Indian Cultural Expansion", *Indian Art and Letters*, Vol. 9, No. 1 (London, 1935), pp. 1-31, and J. L. Moens, "Srivijaya, Yava en Kataha", *Tijdschrift Voor Indische Taal-, Land- en Volkenkunde*, Vol. 77 (Batavia, 1937), pp. 317-487.

2. Dr. C. A. Gibson-Hill, Curator of Mammals in Raffles Museum, Singapore, states that the natural history contained in the passage cannot be used to define the locality of the places mentioned. The description of the monkeys is too vague to allow of their identification; and there is no white falcon with a red head found as a regular species in South-East Asia, but Dr. Gibson-Hill points out that an untrained observer might possibly so describe the cattle egret (*Ardeola ibis*) in its breeding plumage. This bird breeds in the vicinity of the Isthmus of Kra from April to August.

3. Lévi, op. cit., pp. 5-10; and R.-F. St. A. St. John, "Takkola", *Actes du Onzième Congrès International des Orientalistes* (1897), pp. 217-33.

4. See pp. 40-1 above.

5. P. Pelliot, "Bulletin Critique", *T'oung Pao*, Vol. 13 (Leiden, 1912), pp. 453-5.

6. See p. 41 above.

7. Compiled c. A.D. 850, but incorporating information from the *Pen-ts'ao-shih-yi* of A.D. 713-741.

8. Pelliot, op. cit., p. 454.

9. Including in this term the Siamese and Burmese parts of the Isthmus.

still extensive and it might be thought that archæological evidence would help us to identify the site more precisely. In this we shall be disappointed. Along the whole length of the coast from Tavoy to Cape Rachado, in only three areas have there been even exploratory archæological surveys. For the rest, archæological investigation has been sporadic both in time and place, and the map of finds from this period reflects not only the distribution of human activity in former ages, but also the distribution of investigators in this century. Moreover, we must bear in mind the sort of remains we are looking for. None of the sources discussed above provides a description of *Takola*, but in all probability stone- or brick-work featured only in a few buildings of importance. All organic materials such as wood and attap will long since have mouldered away; the lines of the streets—if such existed—will most probably be indecipherable even to the enquiring eye of the archæologist, and the only evidence that we stand on the site of an ancient port will be, perhaps, the brick base of a temple or a group of *stupas*.

The earliest site to be examined with any degree of thoroughness was at *Kuala Selinsing*, set amid the mangrove swamps on the coast of the Matang District of Perak. Here in 1928 Mr. I. H. N. Evans excavated a pile-built village which he believed to be an early Indian settlement[1], and as such it has usually been described by subsequent writers. But in 1936 Dr. Quaritch Wales re-interpreted the evidence as showing the existence of an Indonesian community, probably largely Hinduized[2]. The material yielded by this site does not allow us to date the settlement precisely, but Professor Otley Beyer, on the grounds of a strong typological affinity with a Philippine culture, considers that it probably existed as early as the sixth century A.D.[3] Dr. Wales, at the other end of the time-scale, suggests that it continued into the twelfth century. Clearly there was a settlement here during the period when *Takola* flourished, and the archæological evidence indicates that it had trade relations with places as far afield as Zimbabwe, Zanzibar, Borneo, the Philippines and Korea[4]. But there is no hint that this was indeed the *Takola* of Ptolemy, and some scholars at least would hestitate to identify that port with this pile-built village amid the swamps, whose inhabitants buried their dead in canoes.

In 1935 Dr. Quaritch Wales investigated the site of a settlement on a small island off the mouth of the Takuapa River. The stratigraphy was greatly disturbed, but Dr. Wales claimed that "the evidence of the potsherds alone confirmed that the place flourished between the third and eighth centuries A.D." But he adds ". . . . there was no archæological evidence that would definitely confirm that we were on the site of Ptolemy's second century Takola Mart"[5].

The third locality to have received attention from archæologists is Kedah and the northern part of Province Wellesley. About a hundred years ago, Colonel James Low examined a number of remains in this region[6], and in 1925 Mr. I. H. N. Evans carried out exploratory excavations here[7]; but not until 1936 was the area thoroughly surveyed from the archæological point of view. Then Dr. Quaritch Wales excavated upwards of thirty

1. I. H. N. Evans, "On Ancient Remains from Kuala Selinsing, Perak", *Journal of the Federated Malay States' Museums*, Vol. 12 (Kuala Lumpur, 1928), pp. 121-31, "Further Notes on Remains from Kuala Selinsing", ibid., pp. 139-42; "A Further Note on the Kuala Selinsing Settlement", ibid., Vol 12 (1929), pp. 181-4; "Some Problems of Malayan Archæology", ibid., Vol. 15 (1930), pp. 23-4; "Notes on Recent Finds at Kuala Selinsing", ibid., pp. 25-7.

2. H. G. Q. Wales, "Archæological Researches on Ancient Indian Colonization in Malaya", *J.M.B.R.A.S.*, Vol. 18, pt. 1 (1940), pp. 54-6.

3. I. H. N. Evans, "Notes on the Relationship Between Philippine Iron-Age Antiquities and Some from Perak", *J.F.M.S. Museums*, Vol. 12 (1929), pp. 191-2.

4. I. H. N. Evans, "Excavations at Tanjong Rawa, Kuala Selinsing, Perak", *J.F.M.S. Museums*, Vol. 15 (1932), p. 86.

5. H. G. Q. Wales, "A Newly Explored Route of Ancient Indian Cultural Expansion", pp. 9-10, and *Towards Angkor* (London, 1937), p. 47.

6. J. Low, "A Translation of the Keddah Annals", *The Journal of the Indian Archipelago and Eastern Asia* (Singapore, 1849), pp. 1-23, 162-81, 253-70, 314-36, 467-88.

7. I. H. N. Evans, *Ethnology and Archæology of the Malay Peninsula* (Cambridge, 1927), pp. 105-21.

sites in the vicinity of the Merbok and Muda Rivers[1], including seventeen sanctuaries[2], three buildings provisionally identified as halls of audience and two forts, as well as a number of other miscellaneous finds. Of these sites none was as early as the information contained in Ptolemy, the *Maha Niddesa* or the *Milindapañha*[3]; eight might well have been contemporary with the *Shui Ching Chu;* four appear to date from the period of the *Hsin T'ang Shu;* three from the period of the *Kitab 'adjaïb al-Hind,* the *Sung Shih* and the *T'ai p'ing huan yü chi;* eight approximately from the time of the Tanjore Inscription; and eight were either contemporary with, or slightly earlier than, the *Kitab 'adjaïb al-Makhlukat.* The rest of the sites were either later than any of the literary works which we have discussed, or the evidence was insufficient to date them satisfactorily. In his conclusion Dr. Wales shows that throughout the first years of this era Kedah was an important centre of Hinduized culture, but no evidence has so far come to light to identify this region positively as the hinterland of the port of *Takola.* In fact, Dr. Wales himself expressly discounts the idea on the grounds that the topography of the region is not compatible with the Ptolemaic data, and that, as the *Ilangasogam* of the Tanjore Inscription already occupied the country around the base of Kedah Peak, the *Talaittakolam* mentioned in the same source must be sought elsewhere[4]. There are as well a number of miscellaneous finds in this part of the Peninsula, notably in Perak, where six Buddhist bronzes have come to light, dating from the fifth to the tenth centuries[5]; and Messrs. H. D. Collings and I. H. N. Evans have excavated a cluster of slab-graves in the vicinity of the Bernam, Kruit and Slim Rivers[6]. There is still room for considerable differences of opinion in the dating of these graves, but Mr. H. C. Beck allocated Mr. Colling's collection of beads from such sites to the period between the first and fourth centuries A.D.[7].

Thus, the archæological evidence affords confirmation only of the fact that there were a number of Hinduized, or partially Hinduized settlements scattered along the northern section of the west coast of the Malay Peninsula. None of these sites has yielded evidence as early as Ptolemy's work although at most of them there is material contemporary with the Indian, Chinese and Arab evidence discussed above; and none gives any reason to identify it with *Takola.*

The Testimony of the Map[8]

Most writers on *Takola* have made great play with the circumstantial evidence inscribed on the map of South-East Asia, but in the hands of other than experts this has proved to be an unreliable guide to place-name identification. Two aspects suggest themselves as worthy of study; the external relations of the area in question, and the intrinsic

1. Wales, "Archæological Researches", and, with D. C. Wales, "Further Work on Indian Sites in Malaya", *J.M.B.R.A.S.,* Vol. 20, pt. 1 (1947).

2. Dr. Wales would place the figure higher, but I have omitted some doubtful identifications, e.g., sites 7 and 9, op. cit., pp. 17-8 and 21-2.

3. Though the *Liang Shu* is relating a journey made under the Wu Dynasty, A.D. 222-80.

4. Wales, op. cit., p. 67.

5. Ibid., pp. 50-2; I. H. N. Evans, "Buddhist Bronzes from Kinta Perak", *J.F.M.S. Museums,* Vol. 15, pt. 3 (1932), pp. 135-6.

6. R. J. Wilkinson, "The Bernam Slab-Graves", *J.M.B.R.A.S.,* Vol. 17, pt. 1 (1939), pp. 134-43; R. O. Winstedt, "Slab-Graves and Iron Implements", ibid., Vol. 19, pt. 1 (1941), pp. 93-8; I. H N. Evans, "On Slab-built Graves in Perak", *J.F.M.S. Museums,* Vol. 12, pt. 5 (1928), pp. 111-9, and "A Further Slab-built Grave at Sungkai, Perak", ibid., Vol. 15 (1931), pp. 63-4; H. D. Collings, "Recent Finds of Iron Age Sites in Southern Perak and Selangor, Federated Malay States", *Bulletin of Raffles Museum,* Series B, Vol. 1, No. 2 (Singapore, 1937), pp. 75-92.

7. H. C. Beck, "Beads from Slab-Graves in Malaya", *B.R.M.,* Series B, Vol. 1, No. 2 (1937), pp. 91-3.

8. The terrain of the northern part of the Malay Peninsula may be studied conveniently on a medium scale on 1: 1,000,000, *Asia and the East Indies, G.S.G.S.* 2555 and 4204, Sheets *NB* 47 (*Penang Island*) and *NC* 47 (*Isthmus of Kra);* and on a larger scale on *Hind* 604, *Siam-Kra Isthmus,* 1: 63,360, Sheets *C-47-O, P,, U, V, W* and *B-47-C, D, E, K, L,* and *Hind* 1035, *Malaya, 1:* 63,360, Sheets *2E, 2I, 2M.*

value of any specific site. It has frequently been noted that in the early days of Indian eastward expansion, colonists made the long southern detour through the Straits of Malacca, but that after the fourth century A.D., they came increasingly to adopt the shorter journey across the neck of the Malay Peninsula. If, as the literary evidence leads us to suppose, *Takola* was in this region, it may well have been the gateway to one of these routes. This has led several scholars to try to deduce the routes used by the colonists, and earlier investigators not unnaturally turned their attention to the narrowest part of the Peninsula at the Isthmus of Kra. There seems to be no reason, with Dr. Wales, summarily to dismiss this route as an impossibility[1], but it is true that, although it has been searched fairly thoroughly, no archæological confirmation has so far come to light. Alternative, but longer, routes were those between Mergui and Prachuab in the north; between Takuapa and the Bay of Bandon; between Trang and Nakhawn Sri-Tamarat; and a rather more difficult route between the Merbok River and Patani. The first of these routes has yielded no ancient remains. The second connects two regions of ancient settlement. From Takuapa the river of the same name leads up to a col at just under 2,000 ft., from the far side of which the Khirirat River provides an easy descent into the plain at the head of the Bay of Bandon. In 1936 Dr. Wales found traces of Indian penetration along this route[2], and on the plain beyond stand the remains of the city of Chai'ya[3] and the smaller site of Wieng Sra[4], together with several other shrines and relics dating from the period under discussion. No significant remains have been found at Trang or in its hinterland[5], but at the eastern end of this trans-peninsular route are the archæological sites of Nakhawn Sri-Tamarat, explored by Lunet de Lajonquière at the beginning of this century[6]. Except for Dr. Wales's survey of the Merbok River sites the last of these overland routes, from Kedah to Patani, has not been explored archæologically.

Thus none of these routes is known definitely to have been connected with *Takola,* but other arguments have from time to time been adduced in favour of one or other of them. The periodicity of the monsoon in the Indian Ocean was already known to the west at this time[7], and had doubtless been used by Eastern traders long before, so that there is no reason to suppose that Indian traffic with the Peninsula was wholly by coastal sailing. Dr. Wales, citing the journey of the Buddhist pilgrim, I-ching, at the end of the seventh century[8], assumes that commerce between India and South-East Asia passed through the Ten Degree Channel between the Andaman and Nicobar Islands, and it is then not unreasonable to suppose that traders and colonists from India would make their first landfall on the Peninsula somewhere in the neighbourhood of Takuapa. However, Ptolemy himself tells us that the point on the Indian coast where travellers embarked for the Golden Chersonese was situated on the composite delta of the Kistna and Godavari Rivers[9]. Their route might then perhaps have taken them to the north of the Andamans. Braddell suggests they made their landfall at the Ptolemaic *Sada,* which he identifies as a port on the seaboard of Burma, and then followed the coast southwards to

1. Wales, *Towards Angkor,* p. 56.
2. Wales, op. cit., pp. 51-68, and "A Newly Explored Route of Ancient Indian Cultural Expansion", pp. 22-3.
3. See, for example, J. Y. Claeys, *L'Archéologie du Siam* (Hanoi, 1931), pp. 18-33; and Wales, op. cit., pp. 19-22.
4. Ibid., pp. 17-9, and Wales, *Towards Angkor,* pp. 74-6.
5. For possible remains of an ancient shrine near Trang see Wales, "A Newly Explored Route of Ancient Indian Cultural Expansion", p. 25.
6. See, for example, Lunet de Lajonquière, "Rapport Sommaire sur un Mission Archéologique au Cambodge, au Siam, dans la Presqu'île malaise et dans l'Inde (1907-8), *B.E.F.E.O.,* Vol. 9 (1909), p. 366; "La Domaine Archéologique du Siam", and "Essai d'Inventaire Archéologique du Siam", *Bulletin de la Commission Archéologique de l'Indochine* (Paris, 1909, 1912); and Claeys, op. cit., pp. 13-7.
7. See, for example, Schoff, op. cit., p. 45 and note 57, p. 227.
8. J. Takakusu, *A Record of the Buddhist Religion,* A.D. 671-695 (Oxford, 1896), pp. 30-1.
9. Ptolemy, Bk. VII, Chap. 1, para. 15. See Renou, op. cit., p. 9. Berthelot, op. cit., p. 335, identifies the apheterion as Coringa; so also Braddell, op. cit., Vol. 14, pt. 3 (1936), pp. 17-8.

the Golden Chersonese[1], but this is pure speculation. In fact until we know something of the technicalities of ship construction and navigation as practised by the Indians of this period, all statements about these early sailing routes in the Indian Ocean are largely conjectural and may well be illusory[2].

Hypotheses based on the intrinsic values of various sites are no more certain than are those based on supposed strategic advantages. Dr. Wales, for example, assures us that Takuapa affords "the finest harbour on the whole west coast of the Peninsula"[3]. This is open to question but, in any case, the colonists would not have been particularly attracted by the best harbour. What they were seeking was any suitable haven situated conveniently for their destination. And the best harbour for a modern fleet is not necessarily the most attractive to a solitary sailing vessel. Again we find that our ignorance of shipping and navigation in these waters at this period prevents us from drawing any satisfactory conclusions from a study of harbour potentialities on this coast.

Several writers have drawn attention to the fact that the geography of the Malay Peninsula must have undergone considerable changes since Ptolemy's time, and nearly every physical feature on the west coast has been altered to meet the exigencies of etymological identification. These geographical modifications fall into two groups: the silting up of rivers, and changes in the configuration of the coast. There are, in fact, many authenticated examples of changes in the longitudinal profiles of Malayan Rivers in historical times, and particularly, owing to modern agricultural and mining techniques, during the last hundred and fifty years. The old settlement of Kuala Kubu, for example, was buried by alluvium when mining operations changed the course of the Sungei Selangor, while rubber planting around the headwaters of the Sungei Batang Padang in the early years of this century caused the river to silt up so that, no longer able to maintain its channel, it inundated 30,000 acres of the surrounding countryside, which then became almost inaccessible[4]. Many of these accounts, however, are based on very unsatisfactory evidence. Dr. Wales, for example, noticed the figurehead of a European ship of some 200 tons, and dating from about 1820, in a Buddhist shrine at Takuapa, and assumed that ships drawing ten feet of water could reach the town at the time[5]. But on the evidence he provides the figurehead may have been transported up the river long after the vessel itself had disintegrated. It may be that, as Dr. Wales suggests, large cities could have flourished in, say, the Perak valleys, and yet have been completely destroyed, "their remains perhaps rooted up and disseminated over square miles of river basin"[6]; but it is possibly wiser to invoke such theories only as a last resort.

Most of the changes which have been adduced in coastal form rest on no more certain evidence. Today between Kedah Peak and the Muda River there stretches an alluvial plain through which protrude inliers of red shale. The *Kedah Annals* tell of a large island, usually identified as Kedah Peak, "now becoming attached to the mainland"[7], that is they refer to an island being transformed into a promontory by the accretion of coastal sediments. Dr. Wales thinks that the *Annals* are here referring to the arrival of

1. Braddell, op. cit., Vol. 22, pt. 1 (1949), p. 3.

2. Neither the *Periplus of the Erythræan Sea* nor Ptolemy make any but the vaguest allusions to these matters, but this has not prevented some modern writers from speculating on the problem. Because both the author of the *Periplus* and Marco Polo mention the sewn boats of the Indian Ocean, Dr. Wales argues that "Marco Polo's account of the Arab merchant ships . . . . . will do as well for the early centuries of the Christian era as it did for the thirteenth"; and he adds that, "knowing the conservative character of the Chinese, we may also trust Marco Polo's description of the Chinese junks of his time as applying equally to the early period . . . . . ." (*Towards Angkor*, pp. 30-1). We cannot say at this juncture whether Dr. Wales's assumptions are correct, but they would certainly seem to illustrate a dangerous method of argument.

3. Wales, op. cit., p. 36. The statement is reiterated on p. 55.

4. See D. S. Ferguson, p. 10 above.

5. Wales, "A Newly Explored Route", p. 16, and *Towards Angkor*, p 41.

6. Wales, "Archæological Researches", pp. 49-50.

7. Low, op. cit., p. 8.

either Pallava colonists at the end of the sixth century A.D., or Mahayanists in the eighth, and he concludes that the alluvium of the plain is of very recent deposition[1]. He even goes so far as to reconstruct the drainage pattern of the Kedah Plain in these early centuries[2]. His *Archæological Researches* abound in such sentences as: "Though the swamps bordering the Merbok had not yet formed, and much of the low-lying land north and south of the Peak was still under the sea, it is difficult to believe that the comparatively high neck of land between Bedong and Gurun was beneath the sea in historical times"[3]; or, speaking of the promontory between the Perak and Bernam estuaries, ". . . . in Ptolemy's time the bulge probably did not exist"[4]. Again Dr. Wales states that Province Wellesley, "only became suitable for extensive padi cultivation centuries after the ancient Indians arrived . . . .", and of Bukit Mertajam, "fifteen hundred years ago the sea must have come up very close to it"[5]. Berthelot, on the other hand, contends, against all the available geomorphological evidence, that the Perak shore-line has been receding during the last two thousand years[6], while Gerini propounds the extreme view that Malaya was an island as late as A.D. 50[7]. Such statements as this are wholly unacceptable, but that there is some truth in theories of coastal change is testified by Mr. H. D. Collings's find in a cave at Bukit Chuping in Perlis of a quantity of marine shells, the refuse of a people who had used the creatures as food. Bukit Chuping is now eleven miles inland, and as the molluscs had to be eaten fresh, Collings concludes that the sea formerly approached much more closely to the hill than it does at present[8]. But neither this, nor any of the other scraps of evidence, give us any clue as to the rate at which this negative movement of the sea was proceeding.

Before we can hope to reconstruct the past landscapes of Malaya we must seek the advice of two specialists: the geomorphologist and the archæologist. The former will interpret the morphology of river valley and shore in order to reconstruct the stages of landscape evolution; the latter will relate these stages to the archæological evidence and establish a chronology. Until this is done arguments regarding geographical change will lack that basis of sound scholarship which alone can achieve certainty and finality.

The foregoing discussion makes it clear that it is impossible to define precisely the site of *Takola*. The literary evidence is capable of diverse interpretations, but in the sum it points to the north-west coast of the Malay Peninsula as the locality where we must seek the settlement, and this is not incompatible with what we know of the general tenour of South-East Asian history during this early period. The archæological evidence is indeterminate, while arguments based on the modern map are often plausible but never conclusive. In view of these uncertainties it is surprising to find that numerous authors have identified the site of *Takola* with precision, but always there is a lacuna in the argument or the reasoning depends on such tenuous ampersands that it has to be rejected. Nor does this apply only to *Takola*. Many facile identifications of other early place-names can no longer be accepted and must be subjected to renewed and rigorous investigation. Only then can the geography of early Malaya be elicited with certainty.

1. Wales, op cit., p. 3
2. Ibid, p. 2.
3. Ibid.
4. Ibid., p. 67.
5. Wales, "Further Work on Indian Sites in Malaya", p. 1.
6. Berthelot, op. cit , p. 385.
7. Gerini, op. cit., pp. 77-80.
8. H. D. Collings, "An Excavation at Bukit Chuping, Perlis". *Bulletin of Raffles Museum*, Series B. Vol. 1. No. 2 (Singapore, 1937), p. 111.

THE BANANA INDUSTRY IN TAIWAN

By CHENG-SIANG CHEN

BANANAS ARE conspicuously important in the economy of Taiwan. Between 1936 and 1945 the average annual value of the crop amounted to nearly thirteen million yen[1], a figure falling below those for the other main crops of the island, namely rice, sugar-cane and sweet potatoes, but exceeding that for crude tea. The average area under bananas during these years was 18,000 hectares[2], or about 1·6 per cent of the total cultivated land in the province.

TABLE 1. THE PRINCIPAL CROPS OF TAIWAN, 1936–45

Crop	AVERAGE ANNUAL VALUE OF PRODUCTION		AVERAGE ANNUAL CROP AREA	
	Thousands of yen	As percentage of total	Hectares	As percentage of total
Rice	272,153	47·1	620,560	46·3
Sugar-cane	92,704	16·1	143,430	12·7
Sweet potato ...	40,260	6·9	142,768	12·6
Banana	12,932	2·2	18,003	1·6
Tea	11,581	2·0	42,004	3·7
Others	148,254	26·8	368,550	27·5
Total ...	577,884	100·0	1,335,315	100·0

During the period 1936–45, the average annual value of the fruit produced in Taiwan was approximately twenty-five million yen, of which bananas accounted for 51 per cent; and fruit crops occupied a total area of about 37,400 hectares, of which 48 per cent was under bananas. In addition, bananas formed a larger percentage of Taiwan's exports by value than did any other crops except rice and sugar. This alone emphasizes the importance of banana production in the economic life of the island.

TABLE 2. FRUIT PRODUCTION IN TAIWAN, 1936–45

Fruits	AVERAGE ANNUAL VALUE OF PRODUCTION		AVERAGE ANNUAL CROP AREA	
	Thousands of yen	As percentage of total	Hectares	As percentage of total
Banana	12,932	51·00	18,003	48·16
Pineapple	5,013	19·70	8,128	21·74
Citrus	4,583	18·10	4,881	13·06
Lungyen[3]	861	3·40	2,231	5·97
Others	1,977	7·80	4,139	11·07
Total ...	25,366	100·00	37,382	100·00

1. Statistical information in this paper is abstracted from the *Taiwan Agricultural Year-Books* (Taipei, 1936-45). Between 1930 and 1939 one yen was approximately equivalent to £0/1/5 sterling or U.S.$0.32.

2. 1 hectare = 2·471 acres.

3. *Euphoria longana*, an evergreen tree bearing fruit with a sweet, semi-transparent flesh.

Development of the Industry

Although there is no reliable documentary evidence as to the exact date when the banana was first cultivated in Taiwan, fragmental information from local records would seem to indicate that it was introduced from South China about two hundred years ago, and was first grown in Changhwa, one of the three former districts in the central part of the island. A hundred years later it made its appearance in Taipei, and, owing to the ease with which it could be grown, its cultivation soon spread over the whole of the island. At first it was regarded merely as a pleasing plant of comparatively little utility, to be grown only in the immediate vicinity of the farm house, and even then only for home consumption. It was never marketed.

After the Japanese occupation of 1895 Taiwan began to send bananas to Japan. At that time the quantities were insignificant, and it was not until 1903 that a merchant of Keelung first attempted to dispose of any large quantity in Japan. However, this limited attempt failed to create a market, and bananas do not appear in the customs records until 1907. In 1908 a Taichung merchant sent a large consignment to Japan, which on this occasion was welcomed and formed the nucleus of a Japanese market. In 1909 the completion of the longitudinal railway from north to south of the island greatly facilitated transport throughout the province, and the quantity of bananas exported rose to 51,380 quintals. Henceforth, exports increased year by year, and cultivation was extended to meet this demand. In 1909 the total area under bananas was 543 hectares; by 1936 this figure had risen to 21,850 hectares, a forty-fold increase in crop-area in less than thirty years. During the twenty-eight years from 1909 to 1937 the volume of production rose by thirty-five times[1], and between 1909 and 1941 the value of the crop by eighty times, from 252,099 to 20,304,000 yen.

This rapid development may be attributed chiefly to five factors: (1) the natural conditions in the central and southern part of Taiwan are favourable for banana cultivation; (2) a monopoly of the markets of Japan, Korea and Manchuria acted as a strong stimulus to production; (3) twentieth century improvements in land and sea transport facilitated the export of the crop; (4) the banana plant is easily and simply cultivated, and it is notably resistant to disease; (5) a well-developed co-operative system regulated production and distribution.

Table 3. Development of the Banana Industry

Year	Crop area (hectares)	Thousands of stumps planted	Production (thousands of quintals)	Value (thousands of yen)	Production per hectare (quintals)
1910	679	739	65	530	95·98
1915	2,472	2,692	238	1,120	96·19
1920	3,926	4,274	362	3,865	92·28
1925	17,040	18,552	1,606	7,804	94·24
1930	11,851	13,171	1,301	5,038	109·75
1935	19,957	22,781	1,935	6,593	96·95
1940	18,639	22,682	1,693	18,748	90·81
1945	5,687	5,604	322	7,014	56·54
1950	14,679	16,171	1,173	40,560[2]	79·90

The years 1936 to 1941 were the golden period of the banana industry in Taiwan: acreage, yield and the value of both production and exports were all at their zenith. But after 1942, as the Japanese retreated across the Pacific, shipping routes were obstructed

1. From 63,216 to 2,185,891 quintals.
2. The new Taiwan dollar was introduced in 1950.

and land communications damaged, even obliterated, so that the exports of bananas from Taiwan declined. With this incentive gone, and under the direction of the Japanese, who spared no efforts to increase the production of food crops, banana plantations were converted into fields for other purposes, and production fell away. With the re-cession of Taiwan in 1945, the banana industry reverted to the general situation of 1920, with a crop-area of 5,687 hectares and a production of 321,532 quintals (Fig. 1).

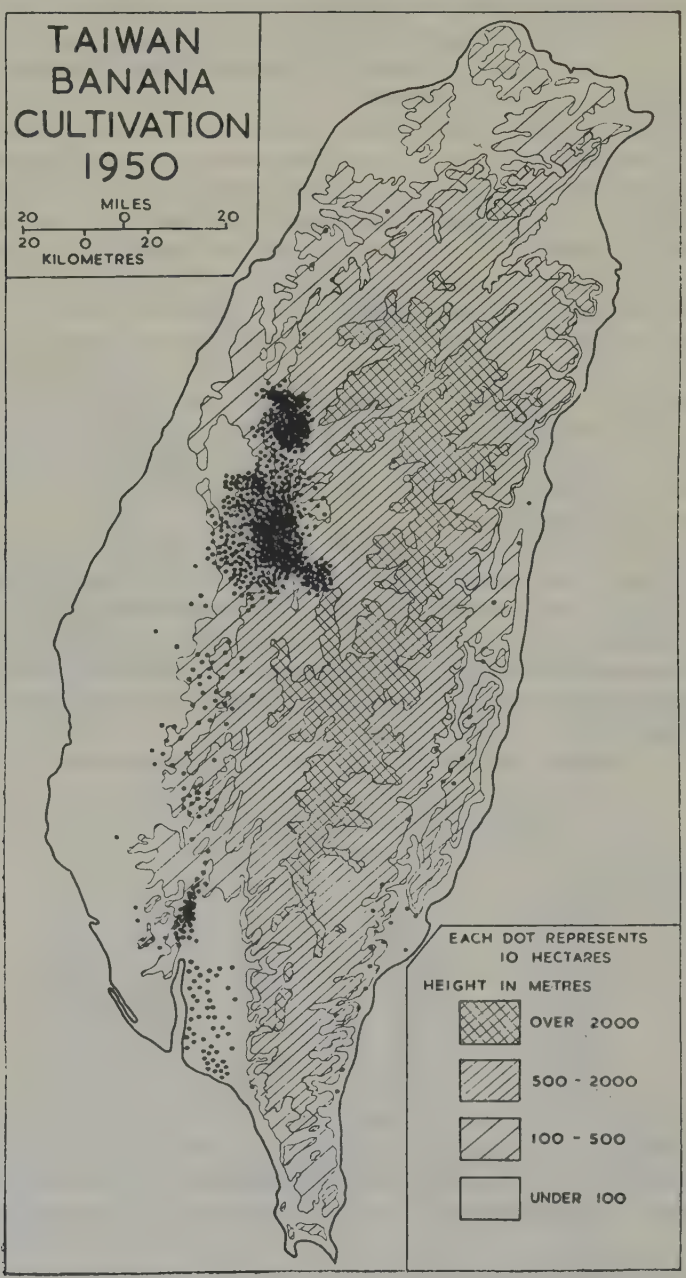


Fig. 1. Banana Cultivation in Taiwan in 1950.

The Distribution of Banana Plantations

Most of the banana plantations are concentrated in the central and southern parts of Taiwan. During the quinquennium 1936–41, approximately 61 per cent of the total area under bananas in the whole of the province was in Taichung District, where there was an average yearly crop-area of 12,532 hectares. Next came the District of Kaohsiung, which accounted for 23·2 per cent of the total crop-area, and Tainan with 11·3 per cent. The other five districts together had only 975 hectares under bananas, less than 5 per cent of the total for the province. Taichung also ranked first among the districts in production with 45·9 per cent of the total, and was again followed by Kaohsiung and Tainan, with 43 per cent and 7·6 per cent respectively. Together these three districts produced 96·5 per cent of all the bananas grown in Taiwan[1].

Table 4. Banana Production in Taiwan, 1936–49

Districts	Period before the Pacific War (1936–41)			Period after the re-cession (1946–49)[2]		
	Crop area (hectares)	Production (quintals)	Production per hectare (quintals)	Crop area (hectares)	Production (quintals)	Production per hectare (quintals)
Taipei	182	21,734	119·4	103	17,498	169·9
Hsinchu	402	27,125	67·5	1,383	75,402	54·5
Taichung	12,532	891,532	71·1	10,468	594,913	56·8
Tainan	2,334	147,534	63·2	953	92,588	97·2
Kaohsiung	4,779	835,354	174·8	1,006	142,732	141·9
Taitung	234	9,699	41·4	243	16,279	67·0
Hwalien	156	10,379	66·5	360	21,293	59·2
Penghu	1	57	73·9	0·3	13	43·3
Total ...	20,620	1,943,414	94·2	14,516	960,718	66·2

When we compare the present situation with that existing thirty years ago we see that significant changes have taken place. In 1920 banana plantations were restricted almost exclusively to the District of Taichung, which had 88 per cent of the area under that crop. Kaohsiung District at that time accounted for only one per cent. But by 1930 considerable changes were already apparent, for the proportion of the acreage in Taichung District had fallen to 64 per cent, while that in Kaohsiung had risen to 22 per cent. By 1940 the percentage in Taichung had further decreased to 54 per cent, and the figure for Kaohsiung stood at 28 per cent. This progressive increase in the cultivation of bananas in Kaohsiung was stimulated by two factors: (1) Kaohsiung winters are warmer than those of Taichung and (2) the development of Kaohsiung harbour provided a ready channel for exports.

By 1930 there had also occurred pronounced changes in the banana-producing area within the District of Taichung. In 1925 most of the plantations had followed a system of intensive cultivation in the lowlands (Fig. 2A), but owing partly to an increase in land rents, and partly to the competition of more profitable crops such as padi and sugar-cane, the banana plantations had gradually become concentrated on the uplands, where

1 See also C. S. Chen. *Land Utilization in Taiwan* (臺灣土地利用) (Taipei, 1950), Map 54, and "Land Utilization in Formosa", *The Geographical Review*, Vol. 41 (New York, 1951), Fig. 25, p. 451.

2. Extensive changes in the administrative divisions of Taiwan since 1949 have rendered the statistics for succeeding years unreliable for purposes of comparison.

production costs were lower, and where an extensive exploitation of the soil could be practised. Today most of the banana plantations of Taichung are to be found among the hills (Fig. 2B). Between 1936 and 1941 an average of 10,551 hectares of upland were under the crop, that is, 84·2 per cent of the total area under bananas in the district[1]. During the same period there were only 443 hectares of bananas on the uplands of Kaohsiung, compared with 4,435 hectares in the lowlands. The total area of banana plantations in this district was 4,779 hectares, so that this was a proportion of 7·3 per cent to 92·7 per cent. In Tainan 2,334 hectares were planted to bananas of which 1,986 hectares, or 85·1 per cent, were in upland plantations, and 348 hectares, or 14·9 per cent, in the lowlands.

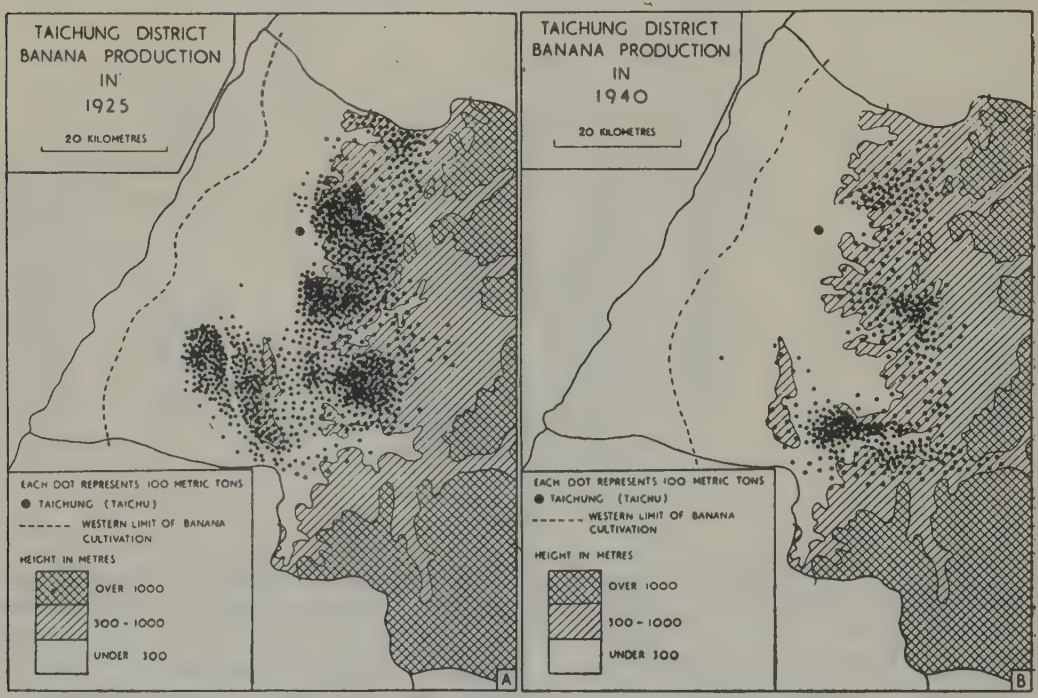


Fig. 2. Banana Cultivation in Taichung District.
(A) in 1925. (B) in 1950.

Lowland banana plantations may be further sub-divided into (1) irrigated padi-field plantations and (2) dry-field plantations. For the period 1936–41, Taiwan had on the average only 1,387 hectares of the first kind[2], and, except for a small acreage at Yuanling in Taichung District, these were wholly within the District of Kaohsiung. At the same time there were 5,736 hectares of banana plantations in dry fields[3], mostly in Kaohsiung District. The upland plantations were more numerous than those in the lowlands and covered 13,497 hectares, or 65·5 per cent of the total area under bananas on the island. The following table shows the distribution of these three types of plantations throughout the island.

1. 12,532 hectares.
2. 6·7 per cent of the total area of banana plantations in the province.
3. 27·8 per cent of the total area of banana plantations in the province.

TABLE 5. BANANA PRODUCTION ON DIFFERENT TYPES OF LAND, 1936–41

District	Types of land	Crop area (hectares)	Number of stumps planted	Stumps planted per hectare	Production (quintals)
Taipei	Padi field	4·1	4,674	1,140	809
	Dry field	110·0	136,323	1,239	13,969
	Upland	69·5	83,902	1,207	7,225
Hsinchu	Padi field	0·3	708	2,360	46
	Dry field	161·1	181,516	1,127	13,815
	Upland	240·5	255,549	1,063	13,288
Taichung	Padi field	101·3	118,607	1,171	16,029
	Dry field	1,879·7	1,719,596	915	152,965
	Upland	10,551·4	10,429,761	988	722,539
Tainan	Padi field	13·5	14,697	1,089	1,447
	Dry field	334·1	452,036	1,353	39,759
	Upland	1,986·1	2,536,743	1,277	106,328
Kaohsiung	Padi field	1,266·5	2,299,883	1,816	239,788
	Dry field	3,168·8	5,719,354	1,805	562,874
	Upland	343·2	435,849	1,270	32,692
Taitung	Padi field	2·3	2,008	873	316
	Dry field	36·2	40,907	1,130	3,325
	Upland	195·7	182,220	931	6,058
Hwalien	Padi field	—	—	—	—
	Dry field	46·7	47,987	1,028	4,102
	Upland	109·4	110,906	1,014	6,277
Penghu	Padi field	—	—	—	—
	Dry field	0·8	1,151	1,439	58
	Upland	—	—	—	—

Banana production may be analysed from two points of view, production per hectare or yield per stump; and the results will vary not only from district to district, but also with differences in the quality of land. Moreover, even in the lowlands, there will be differences between padi fields and dry fields. Turning again to the statistics for 1936–41, we find that for Taiwan as a whole, the average production of bananas was 94 quintals per hectare. But individual districts departed widely from this figure. In Kaohsiung, for example, the average output per hectare was 175 quintals, in Taichung 71 quintals, and in Tainan 63 quintals. In the lowlands the yield per hectare is much above that on hilly land; and, within the category of lowlands, yields per hectare from

padi fields exceed those from dry land. Between 1936 and 1941 each hectare of padi land produced on the average 185 quintals of bananas, while on the uplands this figure fell to 66 quintals. Again, on padi land the average yield per stump was 10·5 kilograms, in dry fields 9·5 kilograms, but on the uplands only 6·4 kilograms.

Cultivation of Bananas

The banana plant is sensitive to temperature conditions, which accounts for the preponderance of plantations in central and south Taiwan, and their scarcity in the north. But even in the centre and south, great attention is paid to the choice of plantation sites, particularly in mountainous districts.

The temperature regime of central and south Taiwan permits the cultivation of bananas throughout the year, but planting usually takes place between January and April for two reasons. In the first place, this ensures that the plants are not tall enough to be seriously damaged by the high winds of late summer and early autumn, the season of typhoons. Second, in the past almost the whole of the Taiwan banana crop has been exported to Japan, where it has reached the market in spring, a time of fruit shortage, and has thus commanded a high price. As the main markets of the future will probably be in Japan and North and Central China, there is not likely to be any significant change in this system.

A variety of land forms induces considerable variations in planting practice. In the lowlands, for example, from 1,400 to 1,800 stumps are planted to the hectare, but on the uplands the number falls to 1,000 or so. Here, too, cultivation is limited to slopes of less than thirty degrees. A month or two before the planting season, the land is cleared of trees and weeds, which are burnt, and then, to prevent soil erosion, the land is ploughed, or built, into terraces, around the margin of which perennial green-manure crops are planted. The banana plants of the lowlands are manured three or four times during their period of growth, the quantity applied depending very largely on the anticipated market price of the crop. No manures are used on the upland plantations, which depend solely on the inherent fertility of the soil, but not infrequently soil erosion and exhaustion cause their early abandonment. Down in the lowlands plantations are irrigated two or three times a month during the dry season. Most of the dry-field plantations in Kaohsiung are irrigated from wells or by means of mechanical pumps.

The banana plant is a perennial with a life of from seven to fifteen years. The first harvest occurs at anything from ten to eighteen months after planting, the exact period depending on factors such as temperature, soil, rainfall and irrigation. Generally speaking the first crop is harvested after eighteen months in the north of the island, after fifteen months in the central part, and after twelve in the south, though in the padi-field plantations of the south the period may be as little as ten months.

Only a small proportion of the banana crop is retained in Taiwan, the bulk being exported. During the period 1931–40 the average annual production amounted to 1,851,094 quintals, of which a yearly average of 1,292,146 quintals were exported, that is, some 70 per cent of the total. This export of bananas began as early as 1907, with just over five thousand quintals, worth about 44,000 yen. This amount increased steadily until it reached its peak in 1935 with an export of almost 1,400,000 quintals, but the trade did not achieve its highest value until 1940 when, although the quantity exported was less than in 1935, it was, at 29,605,940 yen, worth twice as much. This was equivalent to almost exactly five per cent of the total value of the island's exports.

TABLE 6. BANANA EXPORTS FROM TAIWAN, 1907–50

Year	TOTAL EXPORT		TO JAPAN		TO OTHER PLACES	
	Amount (quintals)	Value (yen)	Amount (quintals)	Value (yen)	Amount (quintals)	Value (yen)
1907	5,101	44,129	4,897	43,146	204	983
1910	53,380	345,380	51,331	345,030	49	350
1915	112,196	684,787	112,160	684,564	36	223
1920	83,221	1,806,878	83,090	1,805,518	131	1,360
1925	1,032,777	13,150,700	2,011,628	12,881,395	21,149	269,305
1930	1,046,435	11,419,055	174	10,829,199	57,261	589,856
1935	1,390,701	14,216,211	069	12,088,943	198,632	2,127,268
1940	1,211,562	29,605,940	469	24,808,157	151,093	4,797,783
1945	7,536	—	—	—	—	—
1950	110,000	1,500,000	—	—	—	—

Before the Pacific War, nine-tenths of all the bananas produced in Taiwan were sold to Japan. During the decade 1931–40, there was an average annual export of 1,292,146 quintals, of which Japan took 1,159,954, or 89·8 per cent of the gross total. The remainder was distributed between China and Korea. At that time the trade was almost wholly under the control of three co-operatives, in Taichung, Kaohsiung, and Tainan respectively. Between 1937 and 1939, which was a time of fairly normal conditions, Taiwan exported yearly 1,425,541 quintals of bananas, worth 18,840,991 yen. Of these 1,419,970 quintals[1], worth 18,784,489[2], passed through these three co-operatives.

The banana export trade continues throughout the year, but is particularly active between March and October, when, owing to the shortage of fruit in Japan, prices are usually highest. Between 1938 and 1940, 456,375 quintals of bananas were exported from Kaohsiung, of which 91·4 per cent were exported during April, May and June.

1. 99·6 per cent of the total banana exports.
2. 99·7 per cent of the total value of banana exports.

THE LAND UTILIZATION OF INSEIN DISTRICT, BURMA

A Synopsis of Chapters IV and V of a Thesis presented for the Degree of Master of Arts in the University of Rangoon.

By MAUNG KYAW

GEOLOGICALLY INSEIN DISTRICT is built up entirely of Tertiary and later sediments. In the north-east the folded sandstones and shales of the Pegu and Irrawaddy Series form the deeply dissected Pegu Yoma, with an average elevation of 600 feet, but gradually decreasing towards the south where it forms the ridge separating the Pegu drainage from that of the Hlaing. The alluvial lowlands of the south and west are almost wholly below 50 feet, with a very gentle slope towards the Hlaing and Pegu Rivers. Owing to the level terrain in this part of the District, the rivers are liable to flood during heavy rains. West of the Hlaing River there is hardly any drainage at all and most of the rain water escapes by evaporation.

The climate of Insein District is typical of the tropical monsoon regime of lower Burma with three distinct seasons: a hot season from March to May, a rainy season from June to October, and a cool, dry season from November to February.

TABLE 1. TEMPERATURE, RAINFALL AND WIND DATA FOR MINGALADON (1950)

Month	TEMPERATURE IN °F.			Monthly Rainfall	Mean Wind Direction
	Mean Max.	Mean Min.	Mean Temp.		
January	89·0	62·0	75·5	0.00	NE.
February	93·4	63·1	78·2	0·00	E.
March	98·0	69·4	83·7	0·00	SE.
April	96·6	73·9	85·3	3·32	SW.
May	91·6	76·9	84·2	9·36	SE.
June	85·3	75·6	80·4	20·14	SE.
July	83·9	74·4	79·1	21·82	SW.
August	86·0	75·9	80·9	18·90	SW.
September	85·1	76·0	80·5	14·69	SW.
October	85·7	74·8	80·2	10·40	SE.
November	88·8	72·0	80·4	1·12	NE.
December	84·2	65·5	74·8	8·30	NE.

(By courtesy of the Meterological Department of Burma).

Generally speaking, rainfall increases from the lowlands of the south to the Pegu Yoma of the north. At Taikkyi, for example, the mean annual rainfall is 98 in., but at Mingaladon only 90 in.

No detailed soil survey of the District has yet been undertaken so that only general observations can be made. Two major classes of soils can be distinguished: (1) those in areas of impeded drainage and (2) those in areas of adequate drainage. The Hmawbi padi soil may be regarded as typical of the first type. It is mostly a clay-loam with a stiff sub-soil overlying lateritic sand. After harvest it dries out to a cement-like hardness which allows of tillage only at the break of the monsoon. On the other hand, heavy rainfall on well-drained, upland areas has produced highly leached soils, especially on the slopes of the Pegu Yoma. When brought under cultivation these soils need regular green-manuring with leguminous crops to maintain the supply of organic matter.

(1) CULTIVATED LAND

The cultivated lands of Insein District may be divided into four types:—

(1) Land under crops such as rice, sessamum, sugar-cane, beans, peas and tobacco.

(2) Land devoted to market-gardening and intensive fruit-growing.

(3) Land under tree-crops.

(4) Land occupied by plantation crops such as rubber and dhani.

(i) *Padi Land*

Rice is by far the most important crop in the District, for it occupies almost 90 per cent of the cultivated land. The padi area is almost co-extensive with the alluvial land below 50 feet in height, and only seldom encroaches on to the Tertiary outcrops. Ploughing usually begins in the last week of May. Seed padi is sown in the nurseries in the latter half of June and is planted out towards the end of July. Harvesting begins in the last week of November and is finished by the end of December. In the flooded areas of Tantabin Township the nurseries are confined to the higher areas, notably the levees bordering streams, and the seedlings are taken down to the lower fields on wooden sleds. The annual yield of rice is largely determined by the incidence and amount of rainfall. Scarcity of rain in August, for example, reduces the yield of early maturing varieties, while heavy rain in late October or early November damages late maturing varieties. Early maturing strains (*Kaukyin* and *Kyauklat* are used mostly on the higher padi lands, while late maturing varieties (*Kaukkyi*) are confined to low-lying, flooded areas, where they are assured of an ample supply of water during their longer growing period.

The farmers generally keep enough padi for their own needs and sell the rest to local merchants. Padi is still usually carried by bullock-cart from the threshing floor to the towns and bigger villages, but of recent years motor transport had become increasingly common. From the local markets most of the crop is sent by country boats to the mills at Rangoon. Rail transport is used only from places situated far from a river. The traditional methods of *kyeik* and *maung* (mechanical devices for husking and polishing rice respectively) are still to be seen in some of the more remote villages, but processing is now largely done in rice-mills, which owe their popularity to their capacity and the higher polish they put on the rice. There is considerable variation in the size of the mills. The largest in Insein Town, for example, can mill 2–3,000 baskets[1] of padi a day, while smaller mills in other townships take only from 500 to 1,000 baskets. There are twenty-four of these mills in the District, of which eleven are in Insein Township, seven in Taikkyi, four in Hlegu and two in Tantabin. With the exception of a few large mills in Insein and Taikkyi Townships, the mills all process padi for local consumption. Most of the parboiled rice that enters into the export trade of the area is also milled locally, particularly at Okkan in Taikkyi Township.

The acreage of this type of land occupied by crops other than rice in 1948 was as follows:—

	Acres
Late Sessamum	649
Sugar-cane	202
Tobacco	52
Peas and Beans	31
Maize	28

Sessamum, the typical dry-zone crop of Burma, is usually grown in Insein District during the latter half of the monsoon period. It is confined to the higher ground, and is, therefore, most prominent in Taikkyi Township. The bulk of the crop is consumed in the form of sessamum oil, which is extracted locally, while sessumam cake is used as cattle feed.

Sugar-cane prefers a deep, moist loam, rich in nitrogen, and most of the crop comes from Taikkyi and Hlegu Townships. Two methods of culture are practised in the district, by Indians and Burmans respectively. The Indians plant the canes in the hot weather of March, and cut them in the February of the following year, so that they take a whole year to mature. This is an expensive method of cultivation as it necessitates artificial watering of the plant before the rains come, but it does have the advantage of producing a crop within a year. The method used by the Burmans is less expensive. As the cane is planted in September, during the rainy season, no artificial watering is required, but the cane takes seventeen or eighteen months to mature. Thus, as the land is left fallow for six months after the harvest, this one crop occupies the ground for two years. The yield per acre is high (about 15,000 canes), and it is a profitable crop, but it requires a considerable amount of labour at harvest, and needs frequent manuring.

Tobacco is grown almost exclusively on *kiang* lands[2]. It is a winter crop, and its production is concentrated in Taikkyi Township, especially along the banks of the Hlaing River, and its tributary, the Okkan. The average yield per acre is about 300 viss[3] of dry leaf, and in addition, forty baskets of dry stalks, which can be used as a filler in Burmese cheroots. Maize, also a *kiang* crop, is grown in patches all over the alluvial tracts, but the aggregate area is only small. Generally speaking, tobacco and maize are grown on the same holdings, often with peas, chillies or cucumbers. The maize is of the sweet type, and is used for human food, while the sheath of the cob is used as a cheroot wrapper. The average yield of cobs per acre is 9,000.

1. The capacity of a basket is 9 gallons.
2. Riverine lands which in their natural state support a grass known as *Kiang*.
3. 1 viss = 3·6 lb.

A few fields of peas and beans were formerly grown by some cultivators, especially Indians, after the rice had been harvested. This double cropping of rice lands with legumes should be encouraged for such crops not only increase the farmer's income but also improve the fertility of the soil.

(ii) *Market-gardening and intensive fruit-growing*

Irrigated small-holdings are found chiefly along the eastern base of the Ridge and in the suburbs of Rangoon. Further north they are occasionally found near Wanetchaung, on the eastern side of the railway from Rangoon to Prome, and along the Okkan River. The most intensive form of small-holder agriculture is found near Rangoon, especially bordering the roads from Rangoon to Insein and Thingangyun. The soil is not especially fertile, but great quantities of manure are used and the crop is watered regularly from wells by a primitive mechanical device. These commercial gardens are mostly worked by Chinese. Ladies' fingers, ginger, gourds, roselle and vegetables are harvested towards the end of the rains, while pumpkins, beans, cabbages, cauliflowers and lettuce are grown in the dry season.

Fruit-growing is much more widely dispersed than is vegetable production, for it is usually carried on as one of the household activities in every village. By far the most important fruit is the banana. For commercial production the plants are set in rows about 10 feet apart, and watered artificially during the dry season. After twelve months each plant yields a bunch of bananas weighing from 15 to 25 lb. Then it is cut down and left between the rows to rot; but around the root stalk grow several suckers. Of these from two to five are allowed to develop, which bear fruit in another twelve months. Since this process may be repeated for years without re-planting, it is possible, by having plants of different ages, to harvest every week or every month in the year. Along the roads from Rangoon to Insein and Pegu, banana plantations are usually associated with flower-gardening. The most important flowers are roses, jasmine, cock's comb, and asters. Like other garden crops they require heavy fertilization and artificial watering in the dry season. Nearly all the vegetables, fruits and flowers produced in the District are marketed in Rangoon.

(iii) *Tree-crops*

Orchards, largely of mangoes, marian and jack fruit, occupied nearly 6 per cent of the total cultivated area in 1948, but were almost restricted to the Ridge and the forest margins. Nearly half the acreage is concentrated in Insein Township. During the insurrections, when people feared to go into the jungles, a considerable number of trees in these orchards, especially in the Hmawbi area, were used for fuel.

(iv) *Plantation Crops*

The two important plantation crops are rubber and *dhani* (*Nipa fruiticans*). The rubber tree requires a heavy rainfall, evenly distributed throughout the year, and a well-drained soil, so that the plantations are confined to the slopes of the Ridge and the Pegu Yoma. In pre-war years most of the rubber from the plantations was sent to Rangoon for export, but in the post-war period the bulk of it has been used locally in the rubber-shoe and balloon factories of Thamaing and Thingangyun.

In contrast to the rubber tree, the *dhani* thrives in the swampy lands of tidal areas and is, therefore, restricted to the lower reaches of streams, especially the Pegu, Panhlaing and Hlaing Rivers. The palms are planted in rows four or five feet apart, and take five years to mature. The leaves are cut once a year for thatch, and the juice is often sold as a drink. As a roofing material *dhani* is more durable and less inflammable than palmyra or grass thatch.

In addition to these two main plantation crops there are also a few betel vineyards. As a rule they are small and not tended carefully enough to give the best possible profit. Manure, for example, is by no means always applied. The average yield from 1,000 poles varies from 20 viss of betel leaves in the rainy season to 15 viss in the dry season, when the vine withers and sheds some of its leaves.

(2) Grazing Land

Reserved grazing land is an important feature of the Burmese landscape, and in 1948 occupied 59,268 acres, or nearly 5 per cent of the total area of the District. Although these grazing grounds are widely distributed throughout the rice-lands, nearly half the total are in Hlegu township.

Township	*Acreage*	*Percentage of Township area*
Hlegu	26,418	6·9
Taikkyi	9,392	2·5
Insein	10,384	4·1
Tantabin	13,110	6·2
District Total ..	59,304	

Fig. 1

A. Insein District: Relief and Drainage. The broken line marks the boundary between the alluvium of the lowlands and the sandstones and shales of the Pegu and Irrawaddy Series. Compiled from *Htin Lun A. Burma*, (c. 63, 1960 | Third edition), Sheets 85O/15 and 16; 85P/13; 94C/3, 4, 7, 8 and 94D/1 and 5, and from the Geological *Survey of Burma*, Sheets 85O and P; and 94C and D

B. Insein District: Location Map

Generally speaking, the grazing lands occupy the higher areas which are little suited to crops, and, except in Hlegu Township, are of poor quality. In the region west of the Hlegu River the plains are often covered with elephant grass and are useless for grazing. Livestock enterprises are all on a very small scale. In 1948 there was only one livestock unit[1] to each six acres of crop-land, or only one unit of working stock for each acre of grazing ground. Of recent years there has been a noticeable decrease in the livestock of the District, especially in plough cattle. This may be attributed partly to the Japanese requisitioning of animals for draught and food purposes and partly to the indiscriminate slaughter of cattle by the insurgents. On the other hand, the number of cows and calves has more than doubled since 1944, owing to the Indians of Insein Township increasing their dairy and breeding herds, particularly in the Thamaing and Thingangyun areas, and also because the Government has banned the slaughter of cattle for food. Most of the dairy cattle are Sahiwal or Hariana type cows, which are normally fed on rice-straw. In addition, there are a few goats, and a considerable number of pigs raised mainly to supplement the local meat supply. Goats are kept mainly by Indians, but pigs and poultry are found in nearly all villages. Some Chinese practise commercial duck-breeding in the Thingangyun, Bauktaw, and Kamayut suburbs of Rangoon City.

1. A livestock unit here means one mature head of cattle, horse or mule, two young head of such animals, five sheep or goats or eight hogs.

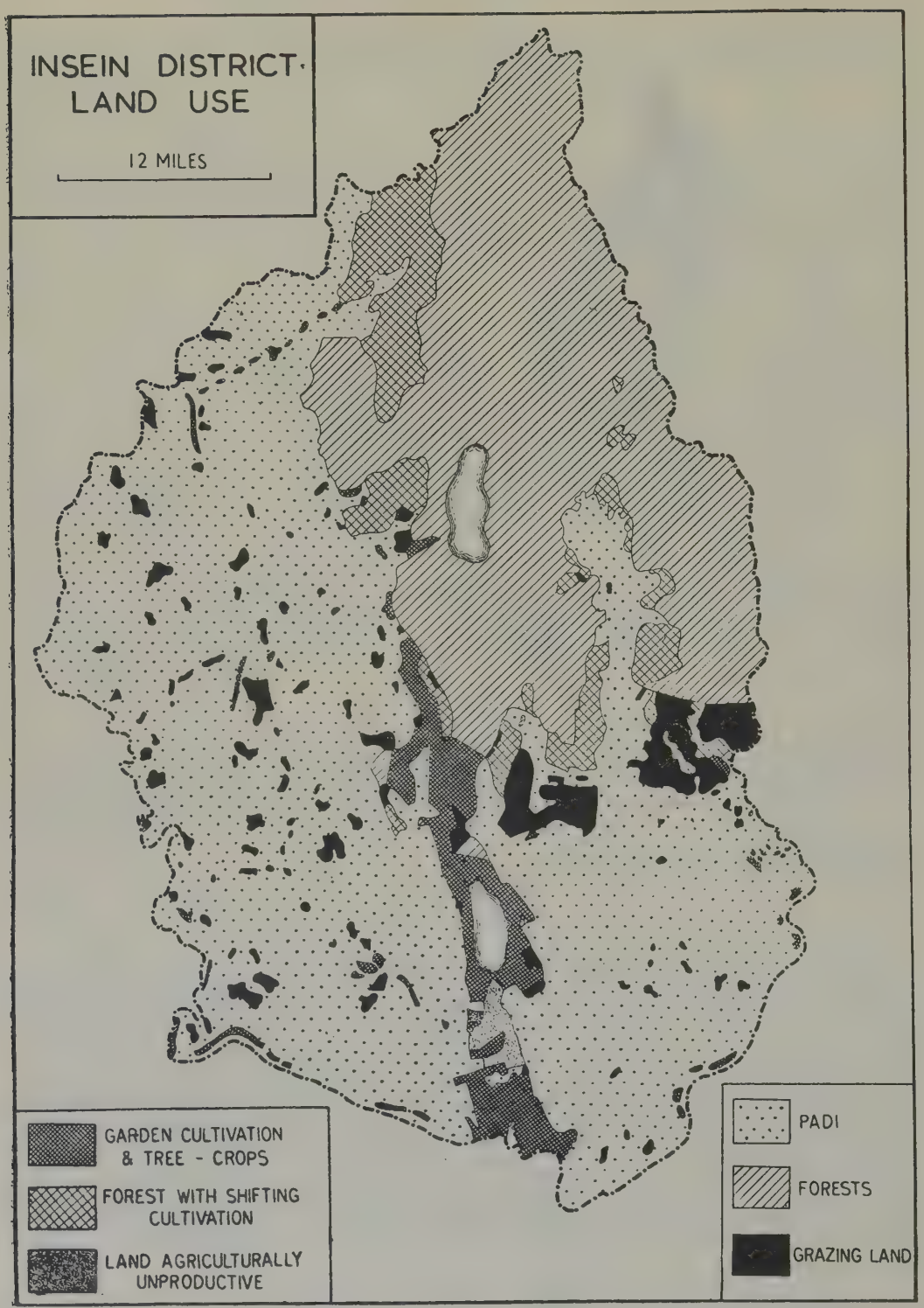


Fig. 2. Insein District: Land Use.

The agriculturally unproductive land comprises Mingaladon airfield, military installations and recreation grounds.

(3) Forests

Insein District has 295,311 acres of Reserved Forests, which though they occupy nearly 25 per cent of its total area, are largely confined to the slopes of the Pegu Yoma. From the ecological point of view three types of forest may be distinguished:—

(1) Tropical evergreen forest, which is restricted to the more humid parts of the Pegu Yoma.

(2) Moist forest, which is characterized by the presence of teak (*Tectona grandis*), pyinkado (*Xylia dolabriformis*) and *Kyathaung* bamboos (*Bambusa polymorphia*), and which is found on the lower slopes of the Pegu Yoma and adjacent plains.

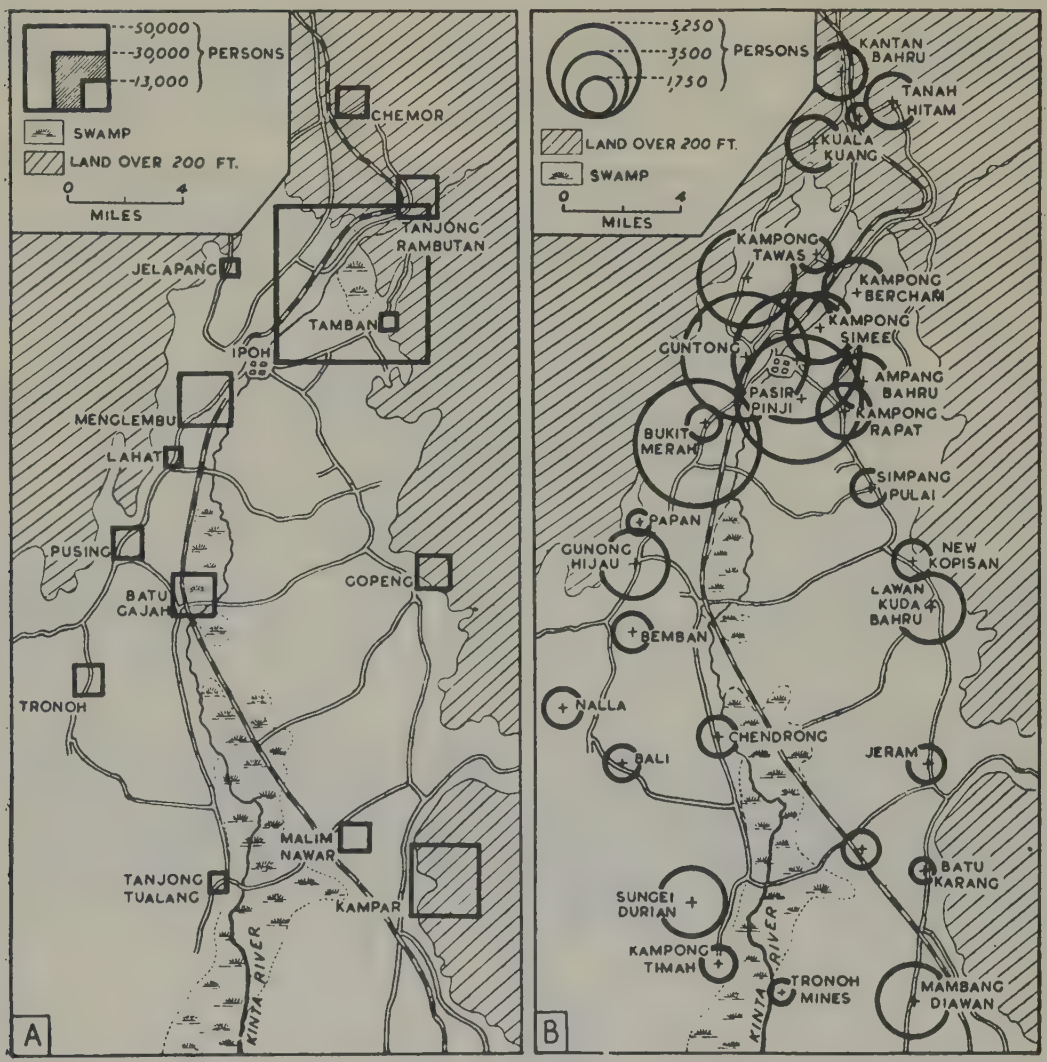
(3) Dry forests, usually at the headwaters of streams. Teak and pyinkado occur but do not attain the same size as in the moist forests, while bamboos are prominent, especially the *thaik* (*Bambusa tulda*) and the *hmyin* (*Dendrocalamus strictus*). For nearly fifty years these Reserved Forests have been carefully managed by the Forest Department, and provide not only commercial timber for export, but also firewood for the local population. Most of the commercial supply comes from the Paunglin, Kalitaw, Mahuya, Okkan, and Hlaing Yoma Reserves. In 1950 the total production of timber and firewood from the Reserved and Unclassed Forests amounted to 19,996 tons and 3,063 tons respectively. Apart from those immediately adjoining the Mahuya and Kalitaw Reserves, most of the Unclassed Forests have been all but denuded of valuable timber. What little teak there may have been was illicitily cut by villagers for domestic use during the Japanese period and during the subsequent insurrections.

Lumbering usually takes place in the dry season. Elephants drag the logs to the banks of streams and pile them in readiness for floating down to the large rivers in the rainy season. Most of the teak from the District is floated down the Hlaing and Pegu Rivers to the saw-mills at Rangoon, but the local mills of Hlegu and Taikkyi Townships consume large quantities of other sorts of timber. Altogether there are six saw-mills in the District, of which three are found in Hlegu, one in Taikkyi, one in Thanatchaung and one in Palou. These local saw-mills supply most of the timber requirements of the District, and the surplus over local needs is sent to Rangoon by road or rail.

Subsidiary Cultivation

One problem which the Forest Department has not completely solved is the control of *taungya* or shifting cultivation on the lower slopes of the Pegu Yoma. Here, cleared patches are formed for a year or two until they are denuded of their topsoil, and are then abandoned for new areas. Within a very short time worthless brush, weeds and grasses encroach on the clearing, and it is many years before the original climax vegetation is re-established. Most of this shifting cultivation is outside the Reserved Forests and, therefore, uncontrolled. One of the major problems of land-use planning in Burma is to bring all the land best suited for forestry under the Reserved Forest Administration, while at the same time providing attractive permanent resettlement opportunities for shifting cultivators.

RECENT SETTLEMENT CHANGES IN THE KINTA VALLEY



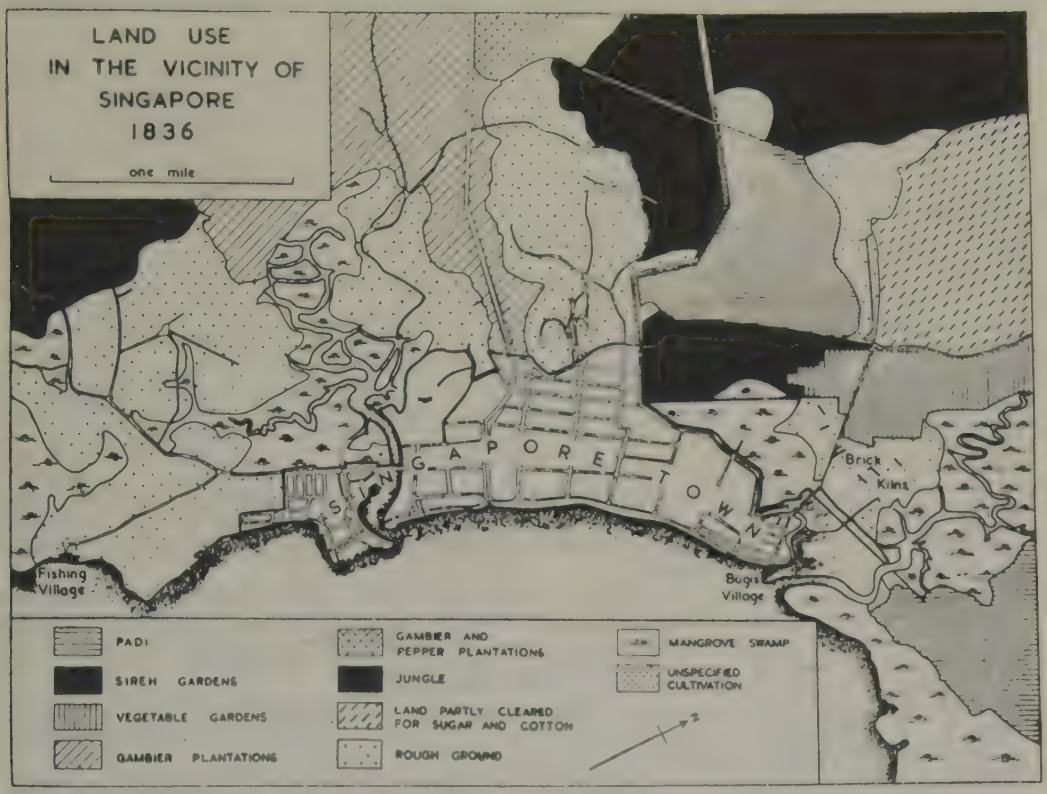
Volume I of this Journal contained an account of the military expedient of re-grouping the dispersed population of Johore State in nucleated villages ("Recent Settlement Changes in South Malaya," pp. 1–8). A similar policy has been enforced in Perak, and these maps show the resulting effects on the settlement pattern of the mining valley of Kinta, where thirty new towns and villages have been created.

A. Towns and villages in the Kinta Valley in 1947. Based on data from M. V. del Tufo, *A Report on the* 1947 *Census of Population* (London, 1949), pp. 162–4. The lower left-hand corner of each square indicates the centre of a settlement.

B. New towns and villages in 1952 after resettlement. Based on data supplied by the District Officer, Kinta. The centre of each circle represents the centre of a settlement.

E. H. G. DOBBY.

LAND USE IN THE VICINITY OF SINGAPORE IN THE EIGHTEEN-THIRTIES



In 1829 Mr. G. D. Coleman began a topographical survey of the Singapore district. The resulting map was published by Tassin in Calcutta in 1836[1], so that the features which appear on it presumably refer to the early eighteen-thirties. The above land-use map is re-drawn from Coleman's map as it appears in Moor's *Notices of the Indian Archipelago*[2]. It depicts three types of landscape:—

(1) The urban landscape of Singapore Town. By the eighteen-thirties the town had come to occupy, or was planned to extend over, most of the plain between the Singapore and Rochore Rivers. The ethnic groupings within the town at this time were described in the last issue of this Journal[3].

(2) Relics of the natural landscape which, in the eighteen-thirties, still survived over most of the Island[4]. The map shows jungle within two miles of the centre of the town, and at one point reaching to the present Kampong Java Road. This patch of jungle persisted for some years after the map was compiled for we find references to it in the *Singapore Free Press* of 1840 and 1844[5].

1. *Map of the Town and Environs of Singapore*, drawn by J. B. Tassin, from an Actual Survey by G. D. Coleman (1836).

2. J. H. Moor, *Notices of the Indian Archipelago and Adjacent Countries* (Singapore, 1837), frontispiece.

3. B. W. Hodder, "Racial Groupings in Singapore", pp. 26-7.

4. Letters from *Inquisitor* and *Triptolemus* in *Singapore Free Press*, 23rd Mar., 1837. In 1841 Col. J. Low estimated that the total land cleared, including the town and suburbs, was not more than 12,000 acres ("Extracts from an Unpublished Journal of a Residence at Singapore During Part of 1840 and 1841", *S.F.P.*, 2nd Dec., 1841), and as late as 1864 J. Cameron remarked that, "By many times the largest part of the Island is still in primeval forest and jungle", *Our Tropical Possessions in Malayan India* (London, 1865), p. 73.

5. *S.F.P.*, 16th Apr., 1840 and 26th Sept., 1844.

Although the greater part of the alluvial plain on which Singapore stands had been drained, extensive mangrove swamps still filled the valleys of the Singapore and Kallang Rivers and their tributaries. As late as 1848 it was estimated that there were 1,000 acres of mangrove swamp within a quarter of a mile of the town[1].

(3) The landscape of cultivation depicted on the map comprises two elements: crops for export and crops for local consumption. The mercantilist policy of the East India Company was espoused with enthusiasm by the early colonists. Not only was the colony to be a strategic asset and an entrepôt, but it was also to yield exportable products wherewith to pay for its protection and administration, and, not least, to provide an outlet for the settlers' surplus capital. Many of the colonists, too, were of that class of lower English gentry accustomed to the management of land, and were familiar from their earliest days with such words as "improvement" and "agricultural geology"[2]. The island was devoid of minerals, but informed opinion still generally believed that the soil was a reservoir of fertility, only awaiting the investment of capital and the advent of labour from China and the Coromandel Coast to yield rich harvests of tropical crops[3]. This belief derived originally from the profuseness of the Island's tropical vegetation, and was confirmed by the apparent success of the early spice plantations. The forests, however, were living on their own decay in a closed nutrient cycle, and the soil was simply providing them with a foothold. Once this cycle was broken by forest clearance, the slender reserves of plant nutriment accumulated over thousands of years were quickly dissipated, while the promised harvest of nutmegs failed to materialize. It is true that John Crawfurd, a shrewd judge of land, had predicted as early as 1824 that the soil of the Island was unsuitable for any commercial crops save gambier and pepper[4], and that some of those whose plantations had failed were inclined to blame their misfortunes on the soil, but in October 1836 the editors of the *Singapore Free Press* came out strongly for the fertility theory. "To maintain the contrary", they claimed, "is .... to dogmatise without data, and to prove oneself over-impressed with the few instances of failure which have occurred"[5]. That these optimistic ideas had so far produced no noteworthy agricultural progress was attributed to the current unfavourable terms of land tenure, the inefficiency of the police who could not guarantee the protection of isolated settlements, and sometimes also to the bad state of the roads[6].

Actually very little of the Island was known to Europeans at this time, and even such an assiduous investigator as Colonel James Low was almost wholly ignorant of conditions in the interior[7]. Moreover, the colonists had no systematic body of knowledge on which they could base their agricultural practices; they usually had no experience of the mechanical side of plantation work; and their labour force was often unskilled in the techniques required of it[8].

The earliest mercantilist experiments were concerned with spices, and particularly with nutmegs, for not only were these the most valuable of all tropical crops, but their successful cultivation in the Straits Settlements would have undermined the existing Dutch monopoly. In the first year of the new settlement Raffles had sent a consignment of nutmeg and clove plants and seeds, together with a letter to the Resident requiring him to "exert your utmost endeavours to establish the cultivation under your immediate authority"[9]. The plants were set out at the foot of Government Hill (now Fort Canning Hill). The cloves tended to die off after five or six years[10], but the nutmegs grew strong and vigorous, and this success induced several residents to make small plantings[11]. In

1. R. Little, "An Essay on Coral Reefs as the Cause of Blakan Mati Fever", *Journal of the Indian Archipelago and Eastern Asia*, Vol. 2 (Singapore, 1848), p. 469.

2. By which was meant an interest in soils.

3. *Agricola*, writing to the *S.F.P.*, 9th June, 1836, enthused, "The soil is good,—the climate fine,—the situation excellent;—and nought is wanting but the hand of man to bring abundance to our own doors". The Agricultural and Horticultural Society's resolution of Oct., 1836 on the subject of a petition to the Right Honourable the Governor-General-in-Council contained the clause, ". . . . . which lead the Society to believe that the soil and climate of the island are well-adapted for the growth and culture of . . . . . the finer kinds of spices, cotton, coffee and sugar". (Reports of the meeting of the Society in *S.F.P.*, 6th Oct., 1836, and *The Singapore Chronicle*, 15th Oct., and 12th Nov., 1836. See also T. J. Newbold, *Political and Statistical Account of the Settlements in the Straits of Malacca*, Vol. 1 (London, 1839), p. 269, and *S.F.P.*, 3rd Oct., 1844.

4. J. Crawfurd, *Journal of an Embassy to the Courts of Siam and Indo-China* (London, 1828), p. 534. Crawfurd reiterated this view in his comments on a proposal for new land regulations in 1838 (*S.F.P.*, 11th Oct.).

5. *S.F.P.*, 13th Oct., 1836.

6. G. W. Earl, *The Eastern Seas* (London, 1837), p. 357. An account of land legislation in the 1830's and 1840's may be conveniently consulted in *One Hundred Years of Singapore*, Vol. 1 (London, 1921), pp. 304-10, while the colonists' views are expressed in numerous letters and editorials in the *S.F.P.* of the period. See also Crawfurd's comments, *S.F.P.*, 11th Oct., 1838; Earl, op. cit., p. 409; Newbold, op. cit., p. 270; G. F. Davidson, *Trade and Travel in the Far East* (London, 1846), p. 40. Complaints about the state of the roads appeared, for example, in the *S.F.P.*, 17th Jan. and 26th Dec., 1839; 2nd, 16th and 30th Jan., 19th Mar., and 2nd Apr., 1840.

7. The geography of the Island was so little known to the colonists that it was commonly believed there was an independent Chinese settlement in the interior, and Earl remarked that its inhabitants were not included in the census returns (op. cit., p. 362). Low's account of the geology purports to refer to the whole island, but from his description of the lithology, it is clear that he was familiar only with the environs of the town (op. cit., *S.F.P.*, 4th Nov., 1841).

8. For a contemporary recital of these difficulties see the letter from *Agricola*, *S.F.P.*, 31st May, 1838.

9. Quoted by T. Oxley, "Some Account of the Nutmeg and its Cultivation", *J.I.A.E.A.*, Vol. 2 (1848), p. 656.

10. Newbold, op. cit., Vol. 1, p. 269.

11. Earl, op. cit., p. 410. In 1824 Canning had prophecied in the House of Commons that after six years Singapore alone would be able to supply the spice markets of Great Britain and the colonies (Newbold, op. cit., p. 269).

the later eighteen-thirties and early forties the landed proprietors of Singapore were seized with a nutmeg mania. Numerous plantations were established and spices invaded many an ornamental garden, where the trees grew up to within a stone's throw of the house[1]. Apart from Crawfurd's warning in 1824, the first public expressions of doubt as to the possible success of spice cultivation were heard towards the end of 1837[2], and Colonel Low also adopted this point of view in his description of Singapore in 1841[3]. His prediction proved true, for, as the Bencoolen and Penang spices came into bearing, the inelasticity of the demand caused prices gradually to fall, and finally disease brought about the abandonment or conversion of plantations. By the eighteen-fifties spice cultivation had failed so completely that the nutmeg came to be known as "the most disastrous deception of all who have engaged in its culture[4]".

The formation of the Agricultural and Horticultural Society in May, 1836 stimulated experimentation with commercial crops, and coffee, sugar and cotton were tried. Sugar probably offered the greatest promise of success and attracted considerable attention[5]. Some of this activity is represented in the north-eastern sector of Coleman's map where J. Balestier was reclaiming a tract of low, clayey ground, preparatory to planting sugar-cane. Two or three other residents also experimented from time to time, while Syme & Co. advertised both hydraulic and steam sugar-mills during the eighteen-forties[6]. But the areas suitable for sugar cultivation, that is, the alluvial soils of the coastal plains, were of such limited extent that Singapore could never have become an important producer, and whatever chance of success the crop might have enjoyed was negatived by a discriminatory tariff on Straits Settlements sugar imported into Great Britain. This, together with the high cost of labour as compared with the West Indies, prevented the industry ever establishing itself.

Together with T. O. Crane and Sir Jose d'Almeida, Balestier was also experimenting with cotton in 1836[7]. Pernambuco, Bourbon, Upland Georgia, New Orleans, Egyptian, Peruvian, Sea Island, Tenevelly and Manila were tried, but none yielded more than a few pods, and those mostly mildewed. An exhortatory pamphlet was addressed to the Chinese planters[8] and free seeds distributed by the Agricultural Society[9], but without effect. Climate and soil alike were ranged against the experimenters. Coffee planters fared no better and the brief history of the Coffee Company may be read in the *Singapore Free Press* of 1839 and 1840[10].

The two crops which Crawfurd had predicted would succeed were gambier and pepper. Planting of gambier seems to have begun as early as 1821[11], but cultivation was not extensive until favourable prices in the English market in 1836 caused a rapid increase[12], and henceforth this became the only successful commercial crop[13]. In 1836 it was estimated that there were about 200 *bangsals*[14] on the Island, occupying 2,350 acres and yielding 22,000 piculs a year[15]; by 1839 there were 350 producing twice that quantity[16], and by 1840 477 occupying 4–5,000 acres[17]. Planters soon discovered that the cultivation of gambier could most economically be combined with that of pepper, and that became the standard practice. The refuse from the manufacture of gambier was the only manure available for the pepper vines, while the price of gambier was seldom high enough to justify its cultivation alone. Opinion varied as to the value of this form of cultivation. In the first place it contributed largely to the clearing of the Island, for in addition to the space required for cultivation, each *bangsal* needed an equal area of forest for firewood. Furthermore, it was confidently believed that the cultivation would contribute to the peace of the Island by providing work for the hordes of

1. Cameron, op. cit., p. 168. The *S.F.P.* and the *S.C.* during these years advertised many properties whose desirability was enhanced by these spice plantings. See, for example, *S.F.P.*, 7th Jan., 18th Feb., 9th June, 1836, 11th Apr., 1839; 3rd Dec., 1840; and *S.C.*, 12th Mar., 1846.

2. E.g., letter from *J.L.*, *S.F.P.*, 9th Feb., 1837; and J. Low, *Supplement to the Dissertation on Penang*, as reviewed in *S.F.P.*, 28th Sept., 1837.

3. Low, "Extracts from an Unpublished Journal", *S.F.P.*, Nov., 1841.

4. Cameron, op. cit., p. 164.

In 1836 most of the spice plants were scattered among numerous private gardens within the town limits and, therefore, do not appear on the map.

5. Earl, op. cit., p. 411; *S.F.P.*, 13th Oct., 1836, 9th Feb., 1837, 31st May, 1838.

6. E.g., *S.F.P.*, 19th Jan., 1843 and succeeding issues.

7. T. O. Crane. "Remarks on the Cultivation of Cotton in Singapore", *J.I.A.E.A.*, Vol. 5 (1851), pp. 120-4. Balestier's estate appears on the map as partly cleared ground in the north-east; Crane was planting at Tanjong Katong and Sir Jose at Kampong Glam. See also the letter by *Agricola* on United States cotton, *S.F.P.*, 18th Feb., 1836; and the editorial in *S.F.P.*, 13th Oct., 1836.

8. *S.F.P.*, 6th Apr. and 6th July, 1837.

9. Ibid.

10. Newbold considered coffee an established and successful crop (op. cit., Vol. 1, p. 270), but although there were a number of Chinese plantations in the interior of the island, none were long-lived.

11. Since this was written Dr. C. A. Gibson-Hill has drawn my attention evidence of gambier cultivation on Singapore Island even before 1819.

12. *S.F.P.*, 29th Dec., 1836.

13. *S.F.P.*, 4th Feb., 1836; Earl, op. cit., p. 410. For detailed accounts of gambier cultivation at this time see *S.F.P.*, 29th Dec., 1836; 28th Mar., 1839; Low, op. cit., *S.F.P.*, 2nd Dec., 1841; and J. Balestier, "View of the State of Agriculture in the British Possessions in the Straits of Malacca", *J.I.A.E.A.*, Vol. 2 (1848), pp. 145-6.

14. Gambier estates.

15. *S.F.P.*, 29th Dec., 1836. One picul = 133·3 lb.

16. *S.F.P.*, 28th Mar., 1839.

17. Census Returns for 1840, quoted in *S.F.P.*, 21st Jan., 1841.

Chinese who were daily arriving in the Colony[1]. On the other hand, by the late 1830's several of the older plantations were rapidly diminishing in value partly from a lack of firewood and partly from soil exhaustion. A few had already been abandoned to *lalang*[2]. This was the beginning of that form of shifting cultivation which, during the next quarter of a century, was to exhaust the reserves of soil fertility over two-thirds of the Island. Being squatters and not proprietors, and as there was still an abundance of virgin land, the gambier planters simply migrated to new areas deeper in the forest when the soil showed signs of impoverishment or firewood became scarce. But the *lalang* which succeeded them proved more costly to extirpate than the original high forest, and, it was held, tended to discourage European planting enterprises[3].

Of the crops grown for local requirements, wet padi never achieved importance, owing to the limited extent of the Island's alluvial plains, the lack of rivers suitable for irrigation, and the ease with which rice could be imported from Bengal, Java and Sumatra. But for some years there were padi fields on the low ground between Serangoon and Bukit Timah Roads, and in the Katong, Siglap and Tanah Merah districts[4]. In 1836 the crop was still important enough to induce Dr. Montgomerie to prepare for the Agricultural Society a paper on the construction of rice-mills[5], but by the early eighteen-forties the padi fields had either been replaced by cash crops or allowed to revert to wastes of rank bog plants[6]. *Sirih* gardens flanked either side of the Serangoon Road, but their aggregate area was small and, as Low remarked, "This cultivation is of little or no value to the capitalist"[7]. Farther along the Serangoon Road, mainly on the gley soils of the lower Kallang valley, the map shows Chinese vegetable gardens. The map offers no information about the kinds of vegetables grown, but Colonel Low a few years later mentions sweet potatoes, yams, *kaladie*, inferior sorts of cabbage and native vegetables as being on sale in the markets[8], and presumably these were the products of the Chinese gardeners.

At this time industry in Singapore was restricted to domestic crafts, together with servicing industries. We read, for example, of gambier and sago manufacture, of blacksmiths' forges and shipwrights' yards, but none of these appear on the map. The only industrial features depicted by Coleman are brick kilns, using the stiff, red clays behind Bugis Village.

Thus Coleman's map shows the landscape in the immediate vicinity of Singapore at the moment when cultivation was first beginning to extend beyond the limits of the town. At the same time, under the ægis of the Agricultural and Horticultural Society, the desultory and unco-ordinated agricultural experiments which had characterized the early years of the settlement were giving place to systematic attempts to develop an export staple.

PAUL WHEATLEY.

1. *S.F.P.*, 29th Dec., 1836.
2. *S.F.P.*, 28th Mar., 1839. *Lalang* is a coarse grass (*Imperata cylindrica*).
3. Balestier, op. cit., p. 146.
4. See Coleman's map and Little, op. cit., pp. 469-70.
5. *S.F.P.*, 8th Aug., 1837.
6. Little, op. cit., p. 470.
7. Low, op. cit., *S.F.P.*, 2nd Dec., 1841.
8. Ibid.

The maps in this volume have been drawn by Mr. Poon Puay Kee.

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